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PYELOGRAPHY AND CHOLECYSTOGRAPHY AS AIDS IN THE DIFFERENTIATION OF SHADOWS DUE TO RENAL OR BILIARY CALCULI[1]

DANIEL N. EISENDRATH, A.B., M.D., F.A.C.S., AND ROBERT A. ARENS, M.D., CHICAGO
From the Urologic and Roentgenologic Departments of Michael Reese Hospital

ONE encounters, from time to time, cases in which the clinical history and objective findings point equally as much to biliary tract as to right kidney infection. If, on radiographic examination, shadows are visible over the right upper abdominal quadrant, the question at once presents itself as to whether these shadows are due to biliary calculi or to renal calculi, or perhaps to the presence of both.

HISTORY

Before the routine employment of pyelography by urologists and the discovery of cholecystography by Graham and Cole in 1924, both radiologist and clinician were obliged to depend on data which, we will attempt to show, are very unreliable.

In 1917, Lewis G. Cole summarized the chief points of differentiation between shadows due to biliary and those due to renal calculi, as follows:

Renal calculi	Biliary calculi
Usually single shadow	Usually multiple shadows
Shadows of uniform density	Either dense nucleus or ring-like shadows
Shadows seldom change position during examination	Frequently change position
Shadows are rounded	Shadows usually facetted or flat
Often branching shadows	Never branching
Shadows vary in size, if multiple	Same size and shape if multiple

B. H. Nichols, a little later, emphasizes some of these points of differentiation. He states that biliary calculi are round, with a center of lesser density, while renal calculi are more commonly oblong and of uniform density.

Young and Waters, in their recent book, direct attention to one of the distinguishing features of biliary calculous shadows as being the presence of centers of lesser density with concentric ringlike formations around such lighter centers. These authors emphasize the advisability of taking lateral views to ascertain if the shadows are extrabiliary (provided that they have been previously included in a cholecystogram).

Braasch and Hager state that the majority of biliary calculi have an accentuated cortex and an indistinct center. According to these authors, biliary calculi are more or less circular and often are seen in clusters or groups. They may, however, assume a great variety of shapes and characters, so as to simulate closely the shadows of renal calculi. They point out the fact, to which we also direct attention later, that in some cases the shadows of both biliary and renal calculi may be identical in location and character.

Our interest in the question of whether one is able to distinguish the shadows of biliary from those of renal calculi was aroused by a

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case published by us in 1927. In this patient it was comparatively easy, with the aid of cholecystography, to state definitely that the shadow in the right kidney region (Fig. 1) was of renal origin. The shadow was triangular in shape and of uniform density.

Shortly afterward a second case presented itself with symptoms pointing to both gall-bladder and right kidney infection. Over the lower pole of the quite distinct renal shadow was a uniformly dense, round, small shadow (Fig. 2, *A*) which one of us felt confident to be of renal origin. In order to ascertain its exact character, a cholecystogram was made. This revealed the shadow to be the calcified center (Fig. 2, *B*) of a relatively large biliary calculus, which was removed later.

Inspection of films in similar cases led us to study the following aspects of the subject.

1. Is the location of a shadow of any assistance in the differentiation of biliary and renal calculi?

2. Can one place any reliance in the above differentiation on the number, the density, form, or change in position of the shadows?

3. Of how much value are cholecystography or pyelography or a combination of the two in such a differentiation?

4. What other shadows must be taken into consideration?

We will take these up in the order named.

1. IS THE LOCATION OF A SHADOW OF ANY ASSISTANCE?

With improved radiographic technique, it is usually possible to visualize the shadows of one or both kidneys on a plain film, unless the patient is very obese or there is too great an accumulation of gas in the colon. The pelvis of the right kidney, as seen on such films, is either located opposite the interspace between the right transverse processes of the first and second lumbar vertebræ (Fig. 3), or a little lower, i.e., in the corresponding space between the second and third lumbar vertebræ (Fig. 4).

When, as often occurs, the right hepatic lobe is also visualized, one is impressed with the degree of overlapping of the upper pole or even upper half of the right kidney (Fig. 4), by the right lobe of the liver and gall bladder. We mention these perhaps familiar anatomical relations because it enables one to understand why a question should at times arise as to whether a shadow is in the gall bladder, or in the renal pelvis proper, or in one of the calyces of the right kidney.

At times, the gall bladder may be directly over the hilus of the kidney. A shadow such as the one shown in Figure 5 might be interpreted as of renal origin from its location, until either cholecystography (Fig. 5) or pyelography are carried out to determine the exact nature of the shadow.

In patients with generalized visceroptosis, the liver (Fig. 6), the gall bladder, and both kidneys are usually at a lower level than normal. In abnormal mobility of the right kidney (Fig. 7) the shadow of a renal calculus is at a lower level, but that of the gall bladder, when visualized by cholecystography, lies usually well above that of the kidney. Under either of the above two conditions, a biliary (Fig. 10, *C*) or a renal calculus may lie very low.

The rapid strides in urologic diagnosis, in which pyelography has played an important part, have enabled us to interpret shadows seen at unusual locations to be due to calculi lying within the pelvis of a horseshoe kidney (Fig. 8) or similar anomalies. Hence, it will be evident that the location of a shadow is not pathognomonic for either a biliary or renal calculus. In a few cases, such as the one shown in Figure 9, the shape, density, and also the location of the shadows appear too high for those of renal calculi.

If shadows are seen during fluoroscopic examination, one can occasionally decide whether they are of renal or biliary origin by the rotation method. This consists in the turning of the patient toward the left or right, the spine being used as an axis. In this way one is able to ascertain whether the suspected calculous shadow lies in an anterior or a posterior frontal plane. If, however, the suspected biliary calculus lies in the same plane as the kidney, this rotation method is of no value.

One can therefore make the deduction, in our opinion, that with but few exceptions, the location alone of a given shadow is of little help in the differentiation of a biliary from a renal calculus.

2. CAN ONE PLACE ANY RELIANCE IN SUCH A DIFFERENTIATION UPON THE NUMBER, THE DENSITY, THE FORM, OR CHANGE IN POSITION OF THE SHADOWS?

Let us consider these items separately.

The number of shadows. Although one is more apt to encounter multiple small shadows in biliary lithiasis, such as are shown in Figure 11, similar multiple small shadows have been encountered in cases of renal calculi by Graham and ourselves.

If there are multiple somewhat larger shadows like those seen in Figure 9 lying over the renobiliary region, one can usually decide that they are of biliary origin if the shadows are faceted and present the alternation in density (light center and dark periphery or vice versa) which is so often seen in biliary calculi (Fig. 12).

In one of our recent cases, in which there were symptoms and definite findings indicative of a right pyelitis, multiple small shadows were to be seen (Fig. 13, *A*) over the mesial portion of the right kidney. We felt that such a location of renal calculi would be very unusual (unless the calculi were in a dilated calyx). In order to be thorough, cholecystography was resorted to. This confirmed our suspicion that the calculi were in the gall bladder (Fig. 13, *B*).

We have encountered a case of multiple, irregular, relatively large shadows with light centers and darker edges over the renal region which were difficult to interpret until, at operation, multiple calculi were found in a tuberculous kidney. Although this occurred on the left side (Fig. 14), it might just as easily be found over the renobiliary region.

The density, i.e., the opacity of the shadows. The older view, that the density of the shadow due to a biliary or urinary calculus depends entirely upon the atomic weight of its constituents, is being discarded. H. P. Kleinschmidt, White, D. E. Shea, and Kairis have made valuable contributions to the question of chemical composition and structure of renal calculi in relation to radiography. The generally accepted view is that the density of the shadow, i.e., the opacity of a renal calculus depends on (a) the atomic weight of its constituents, (b) its structure, and (c) its thickness. Kleinschmidt has proposed a division of renal calculi into soft and hard. Even those whose constituents are of heavy atomic weight (see accompanying table) may be permeable to the X-ray if they are very soft. In order to understand this question of soft and hard calculi, one must be able to visualize the formation of a calculus. Into the colloidal framework are deposited the crystals of the various constituents (Fig. 15) of urinary calculi. Those composed of chemical combinations of heavy atomic weight, as in the accompanying table, would, *a priori*, be expected to give the densest shadows.

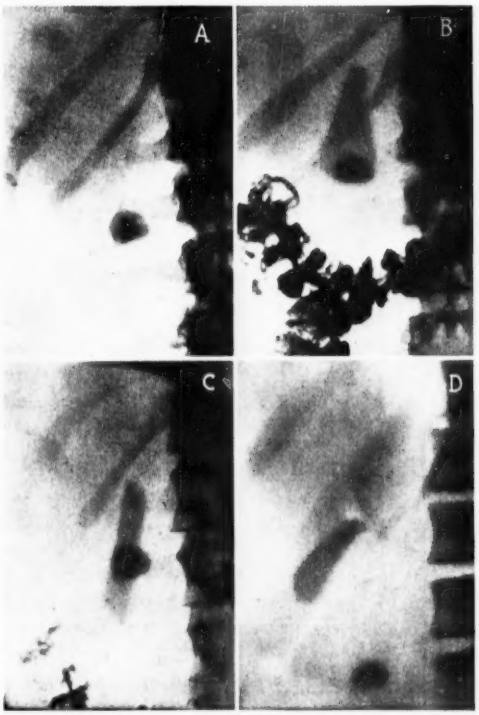

Fig. 1. Although the urologist was confident that the shadow, *A*, seen over the right kidney region could explain the colic-like attacks and pyuria in this patient, the attending physician was of the opinion that the shadow was due to a biliary calculus. Although the shadow seems to be included in that of the cholecystogram, *B*, an exposure at a different angle and a lateral view soon demonstrated its extrabiliary nature. This case and those shown in Figures 1 and 12 illustrate the value of exposures at different angles and of lateral views in doubtful cases.

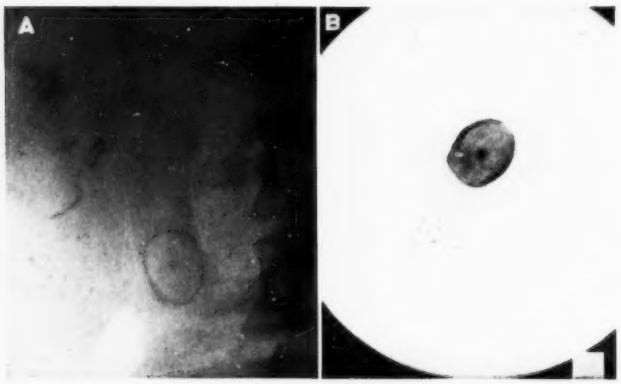

Fig. 2. In this patient there were symptoms of infection of the right kidney and also of the biliary tract. A small shadow of uniform density, A_1 was seen over the lower half of the right kidney. A cholecystogram showed that this shadow was the nucleus of a biliary calculus. After removal of the calculus from the gall bladder it was placed on a radiographic film. Only this more dense central portion yielded a shadow.

COMPONENTS OF URINARY CALCULI
(FROM SHEA'S ARTICLE)

Hydrogen	1	Magnesium	24
Carbon	12	Phosphorus	31
Nitrogen	14	Sulphur	32
Oxygen	16	Potassium	39
Sodium	23	Calcium	40

One can visualize, however, that if the colloidal mesh is loosely constructed and the crystalloids, consequently, deposited at relatively wide intervals, the opacity of such a calculus would be proportionately less.

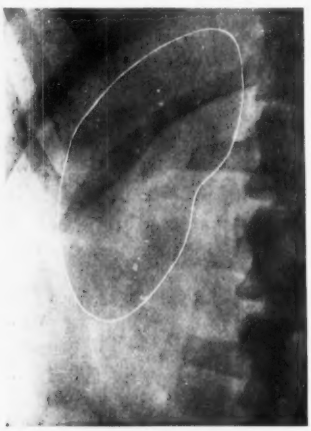

Fig. 3. Plain roentgenogram of right upper abdominal quadrant. The shadow of the right kidney has been outlined. Note location of renal hilus, opposite space between right transverse processes of first and second lumbar vertebræ (compare with Figure 4).

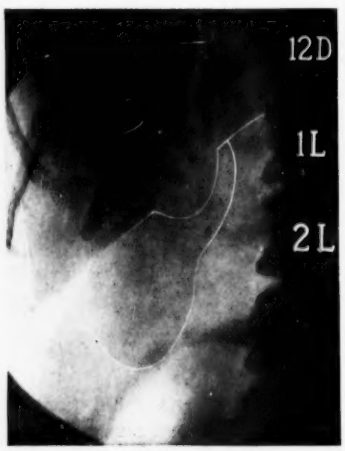

Fig. 4. Plain roentgenogram of right upper abdominal quadrant with lower and lateral borders of right lobe of liver, of gall bladder, and two-thirds of right kidney outlined in white. Note relation of gall bladder to upper half of the kidney. In this patient the right kidney was at a slightly lower level than in the one shown in Figure 3 so that the renal hilus lies opposite space between right transverse processes of second and third lumbar vertebræ. This position of the right kidney as well as the position shown in Figure 3 may be considered as within the normal range.

Fig. 5. Relatively large biliary calculus of uniform density lying directly over hilus of right kidney. Cholecystography revealed the biliary character of the shadow. The edges of the gall-bladder shadow and those of the right kidney were outlined in white. They were to be seen distinctly in the original film but were too faint to be reproduced in an illustration. (Courtesy Dr. S. Strouse and Dr. Binswanger.)

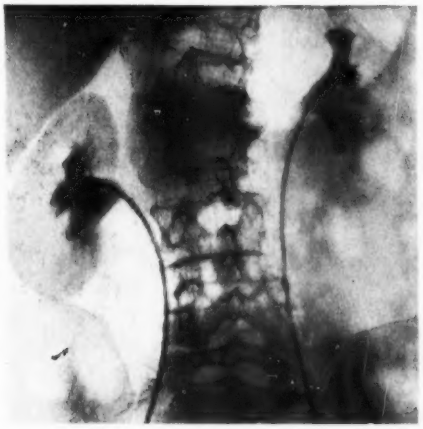

Fig. 6. Location of right lobe of liver and of right kidney in a case of generalized visceroptosis. Note lower position of both kidneys as compared to lower position of right one alone, in case of abnormal mobility of this organ (Fig. 4). In both patients bilateral pyelograms were made.

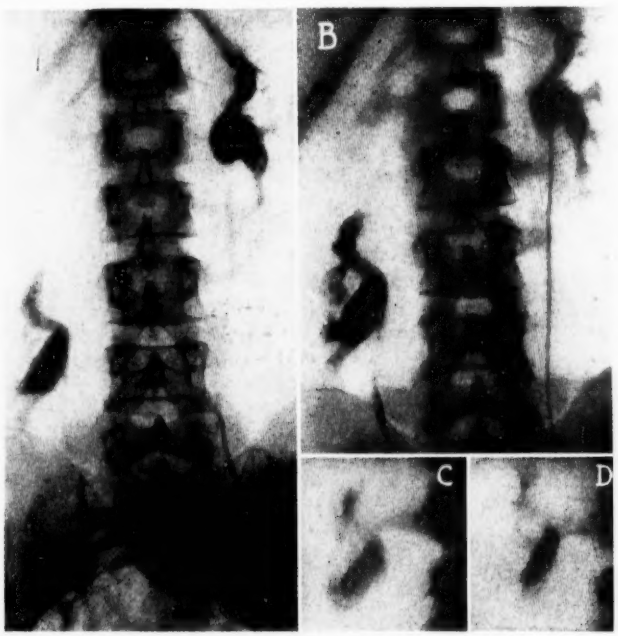

Fig. 7.

Fig. 7. Serial exposures in case of dropped right kidney. *A*, Note low position of right kidney as compared to that of the left; *B*, same before withdrawal of opaque catheter; *C*, 8 minutes after withdrawal of catheter; *D*, 20 minutes after.

Fig. 8.

Fig. 8. Typical location of a calculous shadow close to median line, lying in right half of horseshoe kidney. This can occur only when the corresponding half lies close to the median line, which is not always true of one or both halves of a horseshoe kidney.

Fig. 9. Shadows of two biliary calculi with dark centers and edges lying much higher than would be the case in those of renal calculi. Such cases do not require pyelographic study. (Courtesy of Dr. S. Strouse.)

A similar deduction may be made as to the relation of the thickness of a calculus to its opacity.

One finds somewhat less complicated conditions as to chemical composition, in biliary calculi. Graham divides them into three groups: (a) the cholesterol, (b) the bilirubin-calcium, and (c) the rarer form (imperfectly crystallized and calcium carbonate). Cholesterol, which has a relatively slight X-ray opacity, forms the chief part of most biliary calculi.

It has been estimated that about 10 to 12 per cent of urinary and about 90 per cent of biliary calculi are permeable to the X-ray, i.e., do not yield a shadow. In the case of biliary calculi, this larger percentage is the result of the greater permeability of their chief constituent, cholesterin. For this reason, plain radiography has been found of comparatively little value in biliary lithiasis. We shall refer to this later, in speaking of the value of cholecystography and ureteropyelography in visualizing, respectively, non-opaque biliary and renal calculi.

We thought it might be of interest to compare the opacity of biliary and renal calculi placed on plain radiographic films. A glance at Figures 16 to 21 inclusive shows the result of this study to be as follows:

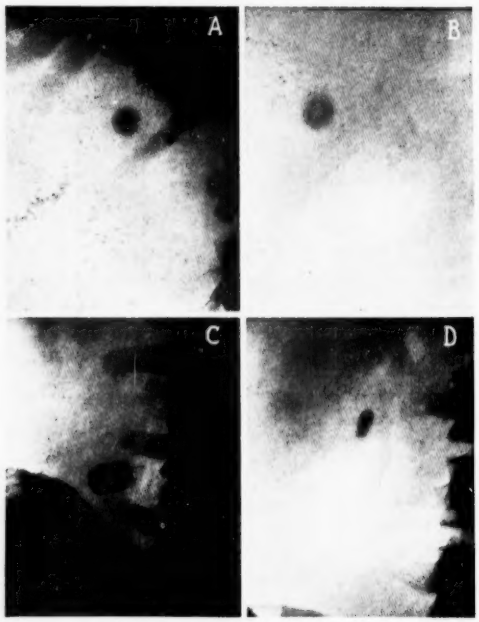

Fig. 10. Shadows in four cases of biliary calculi. *A*, Calculus with dark center and light periphery; *B*, calculus with light center and dark periphery; *C*, biliary calculus located close to crest of ilium in low lying gall bladder; *D*, shadow of calculus in the common duct.

Figure 16 shows relatively large renal calculi. Fourteen of the sixteen calculi yield a uniformly dense shadow. The calculus marked *5*, is a confirmation of what has been said previously as to the opacity of a calculus not only being dependent on the chemical composition but also upon its structure and thickness. At one edge, the structure is quite compact and the resultant shadow quite dark. In the remainder of the calculus (best seen with a magnifying glass) the structure is quite loose and the opacity very faint. These differences in structure are also visible to a less marked degree in the calculi shown as Nos. *1*, *3*, *7*, *10*, *12*, and *13*. Calculus *15* would be practically non-opaque if the film were made clinically, with the calculus in a kidney.

Figure 17 shows small renal and ureteral calculi. One notes the same variation in density as in the preceding figure. None of the calculi fail completely to yield a shadow. Calculus *3* is of interest in connection with the

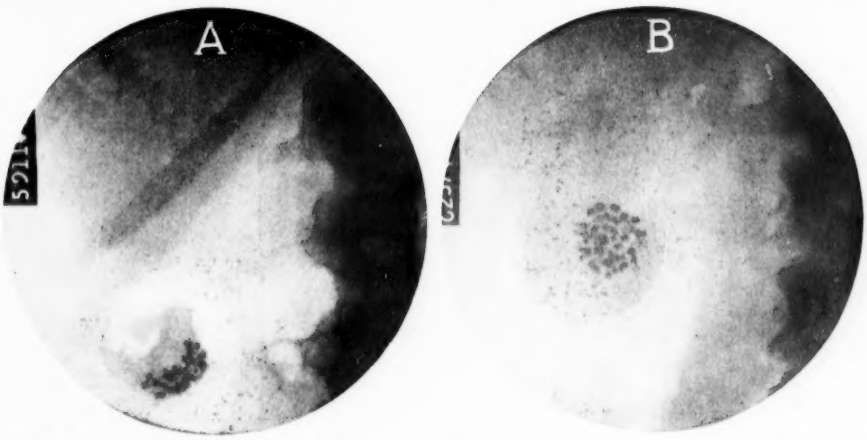

Fig. 11. *A*, Multiple shadows over right renobiliary region; *B*, cholecystography confirmed the biliary character of the shadows. The borders of the faint gall-bladder shadow have been outlined in white, because although distinctly visible in the film, they were too faint to be reproduced in an illustration.

claim that only biliary calculi show a light center and dark peripheral zone. In calculus *11*, the loose structure of the greater portion of the calculus with resultant faint shadow is especially striking.

Figure 18 shows 6 vesical calculi. Only calculus *4* fails to yield a shadow, which bears out a not uncommon clinical experience. One is often able to see a vesical calculus through the cystoscope, when radiography gives negative results.

Figure 19 shows 16 large biliary calculi placed on a film, *A*. The corresponding calculi are shown in *B*. It will be noted that only 2 of the 16 calculi yield a uniformly dense shadow, i.e., without any concentric layers. In *4* there is some deposit of more opaque substance at the upper and lower poles. In Nos. *1*, *12*, and *16* there is distinct lamellation (especially in No. *12*). The remaining ten shadows are so faint that they would hardly show clinically with plain radiography, although the calculi are relatively large.

Figure 20 shows plain film exposure and exterior of 24 moderate sized biliary calculi. Nos. *1*, *2*, *3*, *4*, *8*, *13*, and *23* all show a uniformly dense central and a lighter peripheral zone. The remainder of the calculi yield a shadow which is so faint that it would scarcely show clinically with plain radiography.

In Figure 21, a number of small biliary calculi were grouped to imitate conditions in the living. It will be noted that, with only two exceptions, the shadows are so faint that one could scarcely expect to find shadows clinically on a plain film.

In addition to the above observations, we would like to direct attention to a grouping of the shadows from four cases of biliary calculi (Fig. 10). The shadow seen in *A*, is that of a biliary calculus with a dark center and

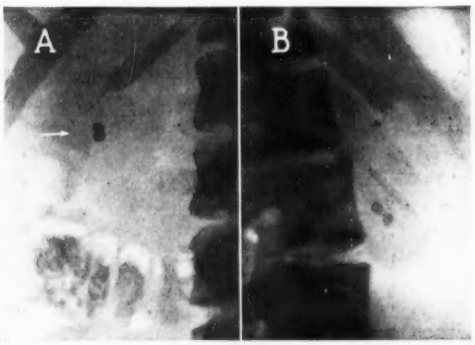

Fig. 12. A plain film taken because of pain over left kidney region in a girl of 17, revealed two shadows with light center and dark periphery over the right kidney region as shown in *A*. A lateral view after cholecystography shows that the shadows lie within that of the gall bladder. (Courtesy of Dr. J. H. Hess.)

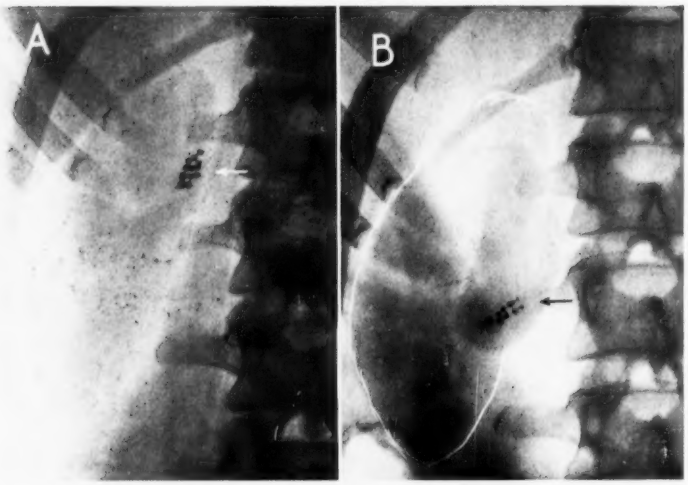

Fig. 13. Patient with symptoms and objective findings of right renal infection. A number of minute shadows (indicated by arrow) were visible in a plain film over the inner portion of the right kidney shadow. They appeared to be too far from the renal pelvis or one of its calyces to be of renal origin. In order to determine their true location, a cholecystogram was made. This showed that the shadows were those of biliary calculi. Note how the gall-bladder shadow lies directly over hilus of kidney in this second exposure. Compare with similar relation in case shown in Figure 5.

light periphery. The opposite is true of the shadow in *B*. The shadow of a common duct calculus seen in *D* is of uniform density. All

Fig. 14. Multiple shadows of calculi in a case of renal tuberculosis. Note lighter center and darker periphery.

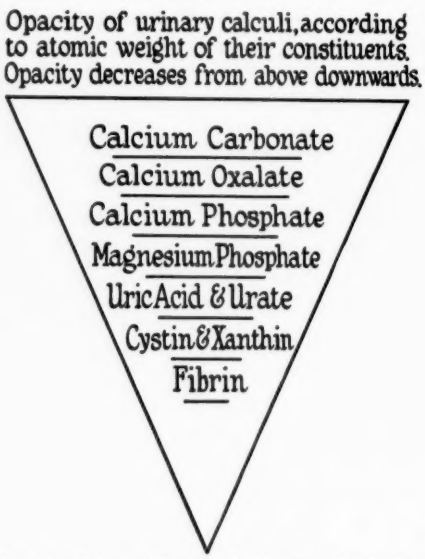
Opacity of urinary calculi, according to atomic weight of their constituents. Opacity decreases from above downwards.
Calcium Carbonate
Calcium Oxalate
Calcium Phosphate
Magnesium Phosphate
Uric Acid & Urate
Cystin & Xanthin
Fibrin

Fig. 15. Order of density of urinary calculi. As explained in the text, this older view that the density of the shadow of any calculus is only due to the atomic weight of its constituents is not accepted. The structure and thickness of a given calculus play equally important parts in the degree of opacity.

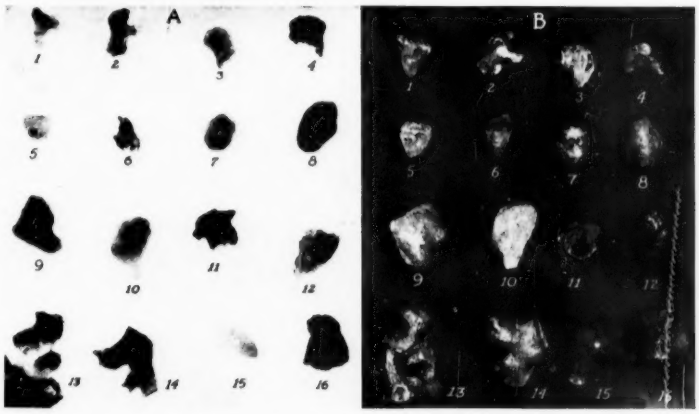

Fig. 16. Renal calculi removed at operation in 16 cases were placed upon a radiographic film in order to compare their opacity. Note the marked variation in density of the shadow as shown in *A* and compare these with the corresponding calculi as shown in *B*.

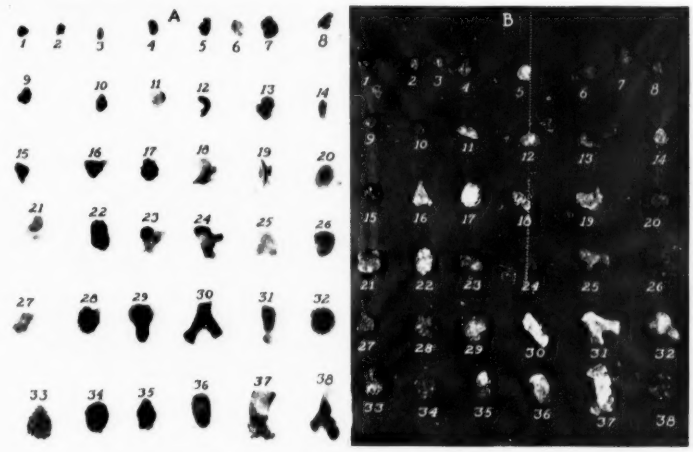

Fig. 17. A large number of renal and ureteral calculi were studied as in Figure 16 in order to learn the variation in the density of the shadows, *A*. The corresponding calculi are shown in *B*.

of these observations compel one to abandon the teaching that there is anything pathognomonic in the density of the shadow of a biliary calculus which enables one to distinguish it from that of a renal calculus.

The form of the shadows. One can at once exclude from consideration the so-called branching or coral renal calculous shadows, such as are shown in Figures 22 and 23. Such shadows do not present any difficulty because they are, to a greater or lesser extent, casts of the renal pelvis proper and its calyces or one or more of the latter alone. In the two cases of concomitant renal and biliary calculi which we have seen, such was the case (Figs. 22 and 23). In Figure 22, the multiple small biliary calculous shadows were at a lower level than the larger branching renal calculus.

One can, for practical purposes, also exclude from consideration shadows which are of

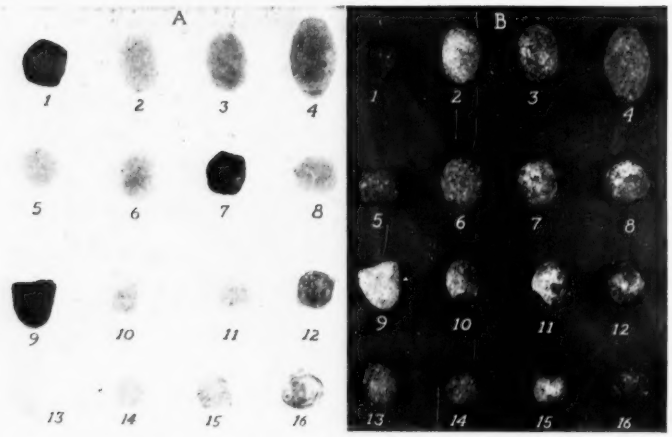

Fig. 19. Sixteen large biliary calculi were placed on a radiograhic film. Note the marked density of some of these calculi as compared to the almost translucency of others. The corresponding calculi are shown in the other half of the illustration.

relatively uniform size and show distinct facets, as in Figures 9 and 12. Such forms are seldom seen in renal calculi. The same is less true of the small, multiple, round, or slightly faceted shadows as seen in Figures 11 and 13. One must always bear in mind the possibility that such findings are occasionally encountered in renal calculi. Having thus excluded from consideration, for practical purposes, the shadows of the branching renal calculus absolutely and the faceted and very small biliary calculi, what remains? The reply is, the oval or round shadows, whether small or large, whether of unequal density or not. Owing to the enormous increase in the number of radiographic exposures of the biliary and right kidney region, this question of differentiation of such oval, round, oblong, etc. shadows constantly recurs, at least in our services. The larger our experience, the less are we willing to make a diagnosis of a given shadow being of biliary origin from its location, opacity, and form. It is in such doubtful cases that cholecystography or pyelography, alone or combined, have proved to be the invaluable diagnostic aids to which we refer later.

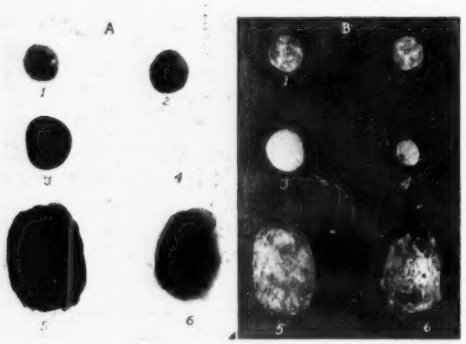

Fig. 18. *A*, Shadows cast by six vesical calculi. Note permeability to X-ray of No. 4. *B*, Corresponding calculi.

Change in position of the shadow or shadows. We regret that our attitude toward this phase of the question is equally as skeptical as that toward the location, opacity, or form of a given shadow in the right upper quadrant, being pathognomonic of biliary or renal calculus.

Urologists find that a renal or ureteral calculus can migrate far more than was ever believed possible before ureteropyelography was as universally employed as at present. It is not uncommon to find that a renal calculus is seen at one radiographic examination to be in the upper ureter or at the outlet of the renal pelvis (Fig. 24, *A*). At another examination it may have changed its axis (Fig. 24, *B*) and at a third, be found in one of the calyces (Fig. 24, *C*). A similar migration is

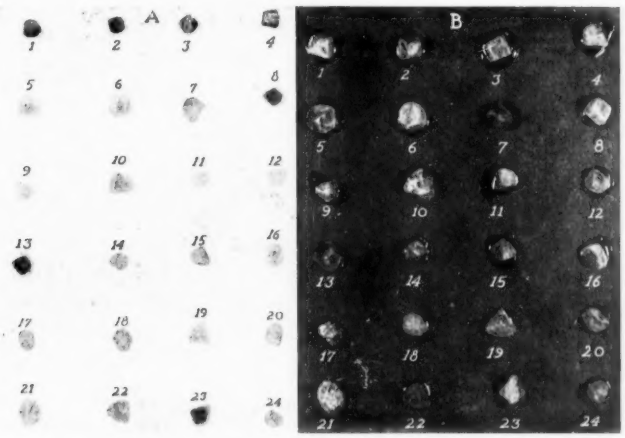

Fig. 20. Twenty-four relatively small biliary calculi were placed on a radiographic film in order to compare the density of the shadows. Note how few of these biliary calculi would yield a shadow sufficient to show on a film in the living. The corresponding calculi are mounted in other half of illustration.

frequently seen when the ureter and renal pelvis are greatly dilated (Figs. 25 and 26). Within the space of an hour, the shadow will be seen, alternately, in the kidney region and in the lower end of the ureter.

In regard to the mobility of biliary calculi, one needs only to inspect such cases as are shown in Figures 12 and 13 to note that relatively small biliary calculi have a relatively wide range of mobility. In Figure 12, *A*, the two biliary calculi (in an anteroposterior exposure) are seen to lie close to the tip of the twelfth rib and on a line drawn through the lower border of the body of the first lumbar vertebra. In a lateral view, these same calculi are seen opposite the middle of the next lower vertebral body. In Figure 13, the multiple small calculous shadows are seen (on a plain film) close to the transverse (right) process of the first lumbar vertebra. In a cholecystogram (Fig. 13, *B*), the same shadows are visible opposite the right transverse process of the second lumbar vertebra.

That large biliary calculi, such as are shown in Figure 19, would change position to any extent, seems hardly plausible. The same is true of multiple faceted calculi of moderate size.

From all that has been said above, regarding the mobility of biliary and renal calculi, respectively, one is forced to the deduction that small biliary calculi can have a wide range of mobility. The same, however, is true of small or even moderately large renal or ureteral calculi, provided that there is a concomitant dilatation of the upper urinary tract (Figs. 25 and 26).

3. *Of how much value are cholecystography or pyelography or a combination of both?* It is beyond the scope of this paper to discuss either the technique or the value of cholecystography in general. We are chiefly interested

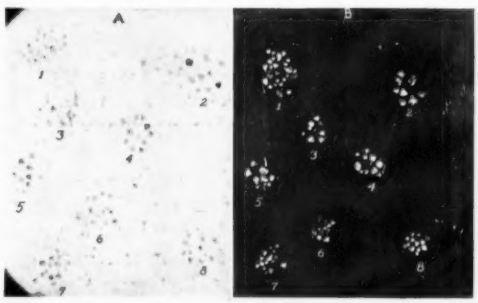

Fig. 21. A number of minute biliary calculi were placed in groups on radiographic films in order to determine the opacity of the corresponding shadows. Note the very faint shadows cast by the majority of these small calculi. In the other half of the illustration are shown the calculi rearranged.

Fig. 22. Concomitant renal and biliary calculi. The calculous shadow lies opposite right transverse process of third lumbar vertebra. The multiple shadows are opposite that of the fourth lumbar vertebra in a low lying gall bladder.

Fig. 23. Shadow of a large branching renal calculus accompanying two shadows of biliary calculi which are outlined in white. There would be no difficulty in recognizing the intrarenal nature of the renal shadow because such a branching shadow is never seen in biliary calculi.

in the question as to whether a shadow in the right upper abdominal quadrant lies in the gall bladder, common bile duct,[1] pancreas,[2] or right kidney.

The value of cholecystography in enabling one to visualize non-opaque biliary calculi is of especial interest, because somewhat similar methods must at times be resorted to by the urologist (Fig. 27). In a series of 2,500 cholecystographies, Case found that, for confirming or excluding the presence of biliary calculi, cholecystography was reliable in 95 per cent of the cases in which calculi were found at operation.

[1] One of the four shadows, i.e., *D*, seen in Figure 10, was due to a calculus in the common duct.

[2] We were shown a film by Dr. Béclère in Paris in which a pancreatic calculus gave rise to a shadow in this area.

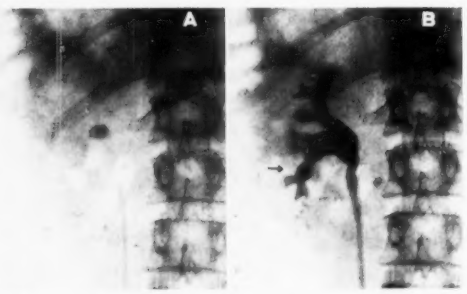

Fig. 24. Two views of one of our cases in which the shadow of a calculus was first seen at a level corresponding to upper portion of ureter. A week later, *A*, it had migrated toward renal pelvis. At operation it was found in a lower calyx as shown in pyelogram *B*.

Before resorting to either cholecystography or pyelography one should take films at various angles by rotating the patient, e.g., anteroposterior, right and left oblique, and lateral positions. If such films do not settle the question as to whether the shadow is in the gall bladder or is extrabiliary, we would suggest the following as a routine procedure:

First, cholecystography alone. If the gall bladder concentrates the dye, one can usually see in an anteroposterior and lateral exposure whether the suspected shadow is intrabiliary or extrabiliary.[3] The cases shown in Figures 1, 2, 5, 11, 12, 13, 28, 29, and 30 are ample evidence of the value of cholecystography, provided that the gall bladder concentrates the dye.

Second, ureteropyelography alone. If the ureter and renal pelvis are filled with an opaque solution (such as 12.5 per cent sodium iodide), the urologist is able not only to determine whether a given shadow is within the

[3] With the exception of common duct calculi. (See Fig. 10, *D*.)

Fig. 25. Shadow of calculus, *A*, and ureteropyelogram, *B*, from case in which calculus constantly migrated from renal pelvis to lower end of ureter and vice versa. (Courtesy of Dr. C. E. Kahlke.)

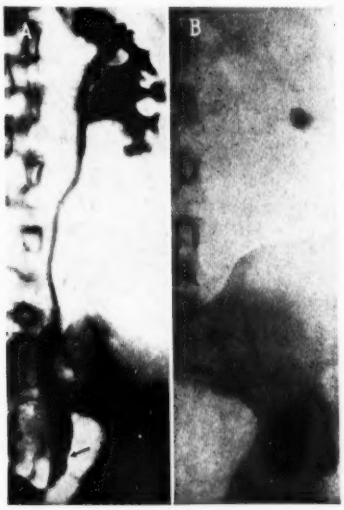

Fig. 26. *A*, Ureteropyelogram of case in which ureteral calculus migrated from its location in pelvic portion of ureter, indicated by arrow, to the renal pelvis as shown in *B*.

renal pelvis or its calyces (Figs. 30 and 31) but also to state with some accuracy the exact location in relation to the pelvis proper or its calyces (Fig. 32). The only exception to the very accurate information obtained by pyelography is in rare cases such as the one shown in Figure 33. Here the shadow of the suspected calculus is separated from that of the pyelogram. We were unable to interpret this finding until, at operation, a calculus was found in a dilated lower minor calyx, the neck of which, or the communication with the pelvis proper and inferior major calyx, had been occluded as the result of stricture formation. Fortunately such a condition is rare; otherwise one would be unable to state that a given shadow is intrarenal because it is "included" in a pyelogram.

Just as cholecystography enables one to visualize biliary calculi which are non-opaque, so with ureteropyelography one can see filling defects or at least lessened opacity (Fig. 27) in some cases of ureteral or renal calculi which are non-opaque.

In several cases in which shadows were seen on the plain film, we were able to identify the shadows as being due to calcified retroperitoneal lymph nodes lying close to the gallbladder and right kidney region. These shadows

Fig. 27. How ureterography or pyelography enables one to visualize a non-opaque calculus. Plain radiography at two hospitals failed to reveal a shadow although a marked obstruction was encountered in the upper portion of the ureter with a ureteral catheter. Note filling defect in the ureterogram where calculus was found at operation. Insert shows shadow of calculus on film after operation. Patient was very obese.

Fig. 28. Large shadow of uniform density over right kidney suspected to be of biliary origin. Cholecystography revealed the extrabiliary character of the shadow. The edges of the gall-bladder shadow have been outlined for the same reasons as given in Figure 11.

(Fig. 34) are always of unequal density, i.e., alternating lighter and darker areas. In addition, their outline is very irregular and serrated. In one case we were able by pyelography to exclude these shadows from consideration as being of biliary or renal origin.

Third, cholecystography and pyelography combined. A combination of these two methods is to be recommended in the following cases:

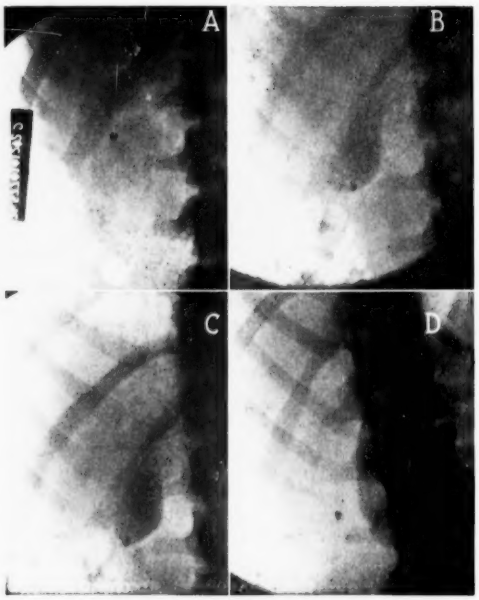

Fig. 29. A shadow was seen over that of the right kidney in a patient with symptoms of renal infection. In order to determine the location of the suspected calculus, cholecystography was resorted to. The first exposure shows the shadow at the lower end of that of the gall bladder, *B*, but projecting slightly beyond it. A second film taken at a different angle shows the shadow more distinctly beyond that of the gall bladder. A lateral view confirms the extrabiliary nature of the shadow.

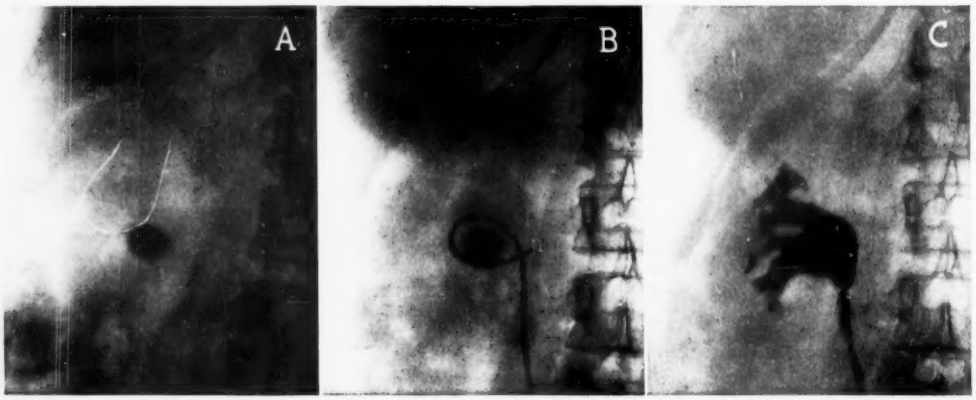

Fig. 30. As in the case shown in Figure 29, a shadow over the right kidney area was at first thought to be due to a biliary calculus. Cholecystography showed that this was not the case, *A*. In order to determine its location, a urologic study was made. This revealed the fact that an opaque ureteral catheter completely encircled the shadow, *B*, and that the shadow was included in a pyelogram, *C*. Pyelotomy was done and a round calculus was removed from a pelvis in which migration had evidently taken place from the renal pelvis to a calyx and vice versa (Fig. 26).

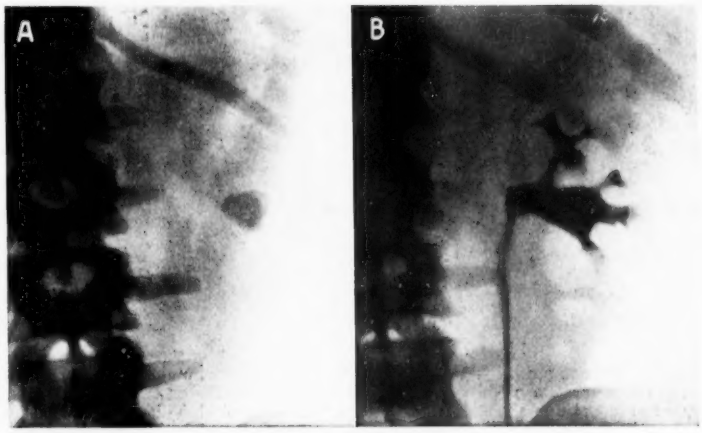

Fig. 31. To illustrate how pyelography demonstrates the intrarenal character of a shadow over the kidney region. Note how the shadow seen in *A* is included in a pyelogram and may be seen as a lighter area, *B*, in a pyelogram.

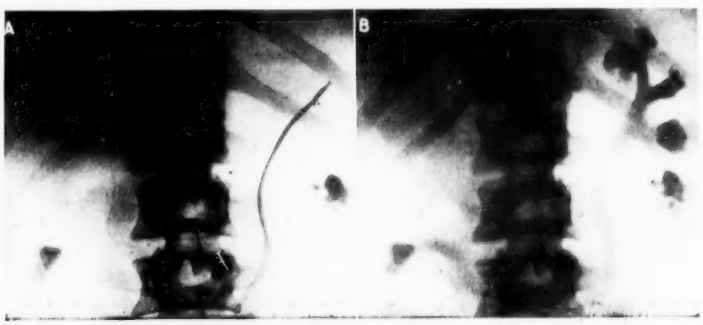

Fig. 32. How pyelography enables one not only to determine the intrarenal character of a shadow but also its exact location in the kidney. The pyelographic medium (12.5 per cent sodium iodide solution) as seen in *B*, cannot be injected beyond the shadow, *A;* thus indicating a calculus impacted at the junction of the ureter with the renal pelvis on the right side. The pyelogram reveals the fact that on the left side the multiple shadows seen in *A*, are located in the inferior major calyx.

a. If cholecystography fails to yield a gallbladder shadow, pyelography will be invaluable.

b. If there is any doubt concerning the intrarenal character of the shadow (Fig. 30, *A*) in spite of its extrabiliary relation to a cholecystogram. Here the relation of the shadow to an opaque ureteral (Fig. 30, *B*) catheter and its inclusion in a pyelogram will enable one to determine the location of the suspected calculus accurately.

c. If the shadows are extrarenal and extrabiliary. In this group are included calcified retroperitoneal lymph nodes (Fig. 34), common duct calculi (Fig. 10, *D*), pancreatic calculi, and pigmented moles. We have encountered two cases during the past year which demonstrate the necessity of bearing in mind that the shadow of a pigmented mole can simulate that of a biliary or renal calculus. Both patients had been sent for radiographic examination because of pain in the right upper quadrant. In one case, the shadow was directly over that of the right kidney. On account of the faint opacity of the shadow, the clinician was advised to look for a pig-

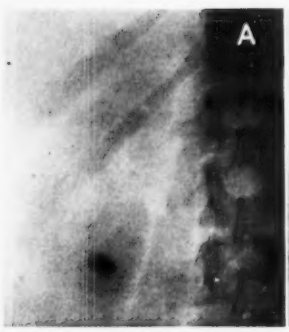

Fig. 33.

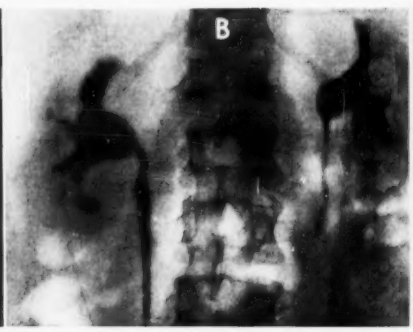

Fig. 34.

Fig. 33. This case illustrates an exception to the rule that one can not only determine the origin of a given shadow as being intrarenal but also localize it within the kidney. The shadow seen in *A* seems to be separated from the pyelogram. At operation the shadow was found to be due to a calculus lying in a dilated lower calyx, the neck of which had been occluded so that pyelographic medium could not enter the calyx.

Fig. 34. Typical shadows due to calcified retroperitoneal lymph nodes in right kidney region. Note variations of density and serrated outline of the shadows.

mented mole on the skin overlying the renobiliary region, where it was found in both cases.

4. *What other shadows must be considered?* The most common shadows which demand differentiation in our experience are those due to calcified retroperitoneal lymph nodes (Fig. 34). The variation in density of the shadow and the dentated edges are quite typical. Calcified areas in a tuberculous kidney, in a hypernephroma, and true calculi in a tuberculous kidney (Fig. 14) can all be distinguished by the use of cholecystography and pyelography, as well as by the irregular density of their shadows (Fig. 14).

COMMENT

1. The older criteria, as emphasized by Cole in 1917, which were employed to differentiate the shadows of biliary and renal calculi, are of little value at the present time.

2. One can exclude from consideration the coral-like or branching renal calculus.

3. The anatomical juxtaposition of the gall bladder and kidney in normal persons makes it possible to confuse shadows of biliary with those of renal calculi.

4. The radiographic opacity of any calculus is not only dependent upon the atomic weight of the constituents but to the structure and thickness of the calculus. "Soft" calculi are much less opaque than "hard" calculi.

5. The form and opacity of biliary and renal calculi have many points of resemblance, so that these two criteria alone cannot be considered pathognomonic.

6. The range of mobility of biliary calculi is, as a rule, greater than that of renal or ureteral calculi. If, however, the latter have formed in a dilated renal pelvis or ureter or both, a wide range of migration is possible.

7. Cholecystography or pyelography or these two methods combined are very valuable additions to our diagnostic resources in the differentiation of biliary and renal calculi. Multiple exposures should be made by rotating the patient, because in some positions the suspected calculus may appear to lie in the gall bladder or kidney, while in others its true position (Figs. 1 and 29) is at once evident.

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THE USE AND ABUSE OF IODIZED OIL IN THE DIAGNOSIS OF LESIONS OF THE SPINAL CORD[1]

WINCHELL McK. CRAIG, M.D., F.A.C.S., ROCHESTER, MINNESOTA
Section on Neurologic Surgery, The Mayo Clinic

IODIZED oil, in the form of lipiodol or iodipin, has played a definite part in the field of diagnosis ever since its introduction by LaFay, Sicard, and Forestier. Lipiodol radiologique descendant, N.N.R., is an iodine addition product of poppy-seed oil containing 0.45 grams of iodine for each cubic centimeter. A similar preparation was used originally by LaFay in the treatment of epidemic encephalitis; later, Sicard and Forestier, finding that it was not unusually irritative to the meninges and that it was opaque to the roentgen-ray, injected it into the subarachnoid space and demonstrated compression of the spinal cord.

Its opacity and low degree of toxicity make it an ideal medium for use in the subarachnoid spaces of the spinal cord in demonstrating the presence or absence of compression of the spinal cord. The injection, executed in the usual manner, either by means of lumbar or cisternal puncture, carries with it but little danger or risk. Observation of the descent of the oil under the fluoroscope and subsequent verification by roentgenograms, determine the level of the compression, or, if there is no arrest in the descent of the opaque medium, confirm a negative diagnosis.

But, comparable to so many other diagnostic measures, the use of lipiodol in this field has not only its limitations but also its elements of danger; consequently, it should be considered as an aid in diagnosis rather than as a measure of primary importance. Mistaken diagnoses have often been made when only one diagnostic procedure has been recognized as the distinguishing factor. So, with diseases of the spinal cord, if the roentgenologic data after the injection of lipiodol are emphasized to the disqualification of other methods of examination, the inference is often misleading.

The test of any procedure is its application over an extended period in the hands of many experienced practitioners. Review of the literature emphasizes the fact that lipiodol is not an innocuous ingredient, which is to be used in all cases of suspected compression of the spinal cord, but that it has its use and abuse. Its greatest use is in the confirmation of the presence of a suspected tumor of the cord, establishing the level of the tumor and demonstrating that discrete compression exists. Its greatest abuse is its injection in cases in which a thorough neurological examination would have elicited sufficient data from which to make a clinical diagnosis.

Sicard and LaPlane, in commenting on the use of lipiodol, emphasized the roentgen-ray data in 2 cases after lipiodol had been used in making a differential diagnosis and stated that more than 300 suboccipital injections had been made under their observation without an accident. However, there occurs an irritative reaction of the meninges following the injection of lipiodol which varies in severity. The variance would appear to depend on the nature of the spinal lesion and the purity of the lipiodol, but the reaction seems to be universal and is the underlying factor in most of the discussions relative to the value of this medium in diagnosis. Balado and Franke said that the reaction is manifested by definite pleocytosis and that the cells called into phagocytic action are polynuclear and mononuclear leucocytes.

In discussing this reaction, Sicard and Forestier commented on a second reaction of the meninges to the introduction of iodized oil; they found that, on the second day after injection, the spinal fluid was clear and contained a normal amount of protein but that there were present from 100 to 200 polynuclear leucocytes in each cubic millimeter. This reaction subsided after the seventh day and unfortunate sequelæ did not result.

Ebaugh and Mella noted carefully the effect in 13 cases; they studied the spinal fluid and observed the systemic effects. They found definite evidence of aseptic meningitis, with increased cell count of the spinal fluid, which subsided in 3 days. The systemic effects

[1] Read by title before the Society of Neurological Surgeons, Rochester, Minnesota, June 11 and 12, 1928.

consisted of pain down both legs, elevation of temperature, nausea, and headache; these were not considered of sufficient consequence to contra-indicate the use of lipiodol in the subarachnoid space.

Lindblom carried out on rabbits a series of subdural injections of relatively large quantities of lipiodol and found that it gave rise to acute leptomeningitis as evidenced histologically by extensive infiltration of cells (mainly leucocytes) in from 2 to 3 weeks. Following this period, evidence of a residual inflammatory process could not be found in spite of large remaining quantities of lipiodol.

Wolfsohn and Morrissey found a definite inflammatory reaction around 2 tumors; one, a neurofibroma and the other, a hæmangioma.

Sharpe and Peterson, in reporting 3 cases in which lipiodol was used in making a differential diagnosis, described a case in which the reaction was so severe that laminectomy was necessary to dislodge the encysted globule of lipiodol.

Hiller described a case of acute serous meningitis in a boy aged 8 years whose illness, before examination, had been of 3 months' duration. There was no segmental level of sensory disturbance nor a spinal fluid block. Lipiodol was used to determine the definite level of the pathological process. At operation evidence of marked inflammatory reaction, adhesions, and a cystic formation were found.

Mackeddie reported 8 cases in which lipiodol had been used to confirm the diagnoses and to determine the level of the spinal lesion. He commented on the invaluable information elicited by its use but noted that he encountered temporary irritation to abnormal nerve tissue.

Mixter and Ayer correlated their observations in experimental animals and in clinical cases and concluded that iodized oil is irritating to the meninges, that it remains as a foreign body and, therefore, that it should be used only when necessary. They further emphasized the absence of a subarachnoid block as a contra-indication to its use.

Armour noticed a distinct meningeal reaction in patients who were submitted for operation shortly after an injection of lipiodol. The meninges appeared thickened and somewhat red, and the cerebrospinal fluid was slightly turbid. He further stated that at the National Hospital, following injection of lipiodol, an increase in root pain at the site of the lesion was commonly found and that this pain lasted for several hours. General soreness and stiffness and headaches occurred, and there was a slight rise in temperature; also, there had been increased difficulty in micturition in cases of lesions of the cauda equina. In a case which eventually proved to be one of disseminated sclerosis, the injection of lipiodol gave rise to twitching of the left arm and leg and to a sensation of "pins and needles" in the left side of the face which lasted for 24 hours. Forestier maintained that severe sequelæ are not due to the lipiodol but to the puncture alone; he did not believe that lipiodol should be regarded as a permanent foreign body, because, even if it takes a long time to be absorbed, the absorption is, at any rate, continuous by means of normal histological reaction. Armour summarized the use of lipiodol by saying that its employment should in no way usurp the place of several and repeated clinical examinations of the patient. He believes that the determination of a segmental level of sensory disturbance combined with a laboratory test of the cerebrospinal fluid is especially important. Recourse to the use of iodized oil as a labor-saving device and a short cut to diagnosis and localization cannot be too strongly deprecated: it should be used only after a subarachnoid block, first demonstrated by the combined cistern puncture which was introduced by Ayer; also, it should not be employed unless the possible danger of complications is outweighed by the more exact localization likely to be obtained. Finally, in properly selected cases, lipiodol is a definite aid in the study of compression of the spinal cord which, if used intelligently, will definitely increase the possibility of successful removal of tumors of the spinal cord. Furthermore, the tumors can be detected and removed at an earlier stage in the course of the disease; thereby the percentage of cures is increased and the operative mortality is reduced.

REPORT OF CASES

Diagnosis and localization of tumors of the spinal cord have been materially improved since

the introduction of iodized oil, and a review of a series of cases at The Mayo Clinic has emphasized many pertinent facts. Lipiodol radiologique descendant, N.N.R. was injected in every case into the cisterna cerebellomedullaris (cisterna magna) with the patient in a prone position. When the patient was removed to the fluoroscopic room, the head of the fluoroscopic table was gradually elevated and the iodized oil was observed to descend in the subarachnoid space; following the fluoroscopic examination roentgenograms were made; after an interval of 12 and 24 hours, a second and a third series of plates were made. The combination of these roentgen-ray examinations constituted the diagnostic results of the injection of lipiodol. Ten cases were selected to exemplify one or more points of interest, and, for convenience in summarizing the advantages and disadvantages of the use of lipiodol in these cases, the points were listed as uses and abuses. The first 5 cases illustrate the uses of iodized oil, and the case histories evaluate not only the justification of its employment but also the invaluable information elucidated by subsequent roentgen-ray examination.

The first case presents a picture of numbness and weakness of the lower extremities with an insidious onset and without a history of pain. A definite segmental level of sensory disturbance was elicited on careful neurologic examination, but when spinal puncture was made block could not be demonstrated in the subarachnoid space. Contrary to the observation of many contemporaries, that lipiodol should not be used in the absence of subarachnoid block, and in accord with the observation of a few others, injection of the cisterna cerebellomedullaris was carried out; definite compression and block, corresponding to the level of sensory disturbance, was established by means of lipiodol.

CASE 1. The patient reported at The Mayo Clinic October 17, 1927, complaining of numbness of both legs. The history was of one and one-half years' duration; the legs had become numb simultaneously and the numbness had extended slowly and gradually to the epigastrium. Slight weakness developed about 6 months after the onset of the numbness, and at the same time a heavy piece of iron fell on the patient's left foot without causing subsequent pain. Associated with the numbness and weakness, unsteadiness of gait and slight pain down both legs developed. A few months before admission both vesical and anal sphincters had become involved, which necessitated enemas and the use of a catheter. General examination, including a roentgenologic examination of the spine, was negative. Neurologic examination revealed a level of sensory disturbance corresponding with the seventh dorsal segment, with bilateral decrease in strength and tonus of all muscles below this level. Patellar and tendon of Achilles reflexes were moderately increased bilaterally (graded 2+) and there was bilateral ankle clonus; both cremasteric reflexes were abolished, and there was lack of coordination bilaterally in the heel-to-toe test; the gait was markedly ataxic and both lower extremities were spastic. Examination of the spinal fluid revealed negative Kolmer and positive Nonne reactions; there were three small lymphocytes in each cubic millimeter. The fluid was clear and colorless. On bilateral compression of the jugular veins there was prompt elevation of the level of the fluid in the manometer; this is Queckenstedt's sign, and henceforward in this paper this portion of the examination will be referred to, simply, as the "response to jugular pressure." In view of the absence of spinal block, negative roentgenological examination, and the presence of cells in the spinal fluid, a diagnosis was made of a lesion of the spinal cord, probably inflammatory, and injection of lipiodol was advised. Two cubic centimeters of lipiodol radiologique descendant, N.N.R. were injected into the posterior cistern and under the fluoroscope were seen to descend to about the fourth dorsal vertebra where the lipiodol split into two columns and stopped at the level of the sixth dorsal vertebra. Twelve hour and 24 hour roentgenograms verified this observation (Fig. 1). Exploratory laminectomy was advised and performed, consisting in the removal of the spines and laminæ from the fourth, fifth, and sixth dorsal vertebræ; a definite tumor was found, situated opposite the fifth and sixth dorsal vertebræ on the dorsal aspect of the cord and the dura, producing a saddle-like mass around the cord. It came from the vessels opposite the sixth dorsal vertebra on the right side. The tumor was completely removed without breaking its capsule and proved microscopically to be an hæmangioma. The patient made an uneventful convalescence and regained control of the sphincters; at dismissal, he was able to walk about without difficulty and sensation was beginning to return to the lower extremities.

In accordance with the dictum, sometimes given, that a diagnosis of tumor of the spinal cord cannot be made definitely unless there is no response to jugular pressure and in spite of the observation that lipiodol should never be used in the absence of subarachnoid block, in another case in the series iodized oil was utilized to localize a tumor. Forestier, in emphasizing the use of iodized oil in lesions of the

spinal cord, has stated repeatedly that tumors should be localized earlier by utilizing this diagnostic measure in comprehensive examination. The following case and the previous one illustrate the truth of Forestier's contention. It is possible that with a definite level of sensory disturbance exploration would be justified, but in the absence of other confirming signs, it is most reassuring to have roentgenograms verifying the site of the lesion.

Case 2. The patient, a woman, came to The Mayo Clinic June 2, 1927, complaining of weakness and numbness in the legs which had been gradually progressive during the 2 previous years. The difficulty began with numbness and a drawing sensation in the right heel, following which weakness developed in the right foot. The weakness then spread to the left foot and gradually involved both legs. For 5 months before registration, the patient had been unable to walk except with a cane or with help. With the increasing weakness, pain developed in both extremities. The pain came on at night, usually about 2 a.m., and was relieved by getting up, walking about, and assuming a sitting posture. General examination, including a roentgenologic examination of the spine, was essentially negative. Neurologic examination showed loss of strength of the muscles of both lower extremities; patellar reflexes were increased bilaterally and there was loss of abdominal reflexes; bilateral Babinski, Oppenheim, and Chaddock reflexes were present; a disturbance of sensation, the upper level of which corresponded with the distribution of the eighth and ninth dorsal segments, was noted. Examination of the spinal fluid showed negative Kolmer and positive Nonne reactions, and normal color. There was prompt response to jugular pressure. In view of the history and the neurologic data, a diagnosis was made of lesion of the spinal cord opposite the eighth dorsal vertebra, but because of the response to jugular pressure, injection of iodized oil was carried out. Two cubic centimeters of lipiodol were injected into the cisterna cerebellomedullaris, and, under the fluoroscope, it was seen to flow readily to the level of the seventh dorsal vertebra, where it formed a U-shaped block. Roentgenograms, taken later, verified this (Fig. 2). Accordingly, a diagnosis was made of tumor of the spinal cord and laminectomy was advised; at operation a rounded tumor, arising from the arachnoid and the dura, was found opposite the eighth dorsal vertebra (Fig. 3). The tumor was an intradural fibroblastoma, producing indentations of the cord and reducing the cord to about four-fifths of its normal size. The tumor was removed and the patient made an uneventful recovery.

The ultimate aim of every diagnostician is so to interpret the pre-operative data that a differential diagnosis of the underlying pathological process can be made. In the use of lipiodol, the interpretation of the roentgenogram is of paramount importance and to the shape of the shadow cast has been attributed the indication of the nature of the lesion or the process involved. Mixter stated that a cap or crescent, complete or incomplete, should be interpreted as an extramedullary tumor or Pott's disease with an intraspinal abscess, and that narrow lines of lipiodol at either side with an irregular mass above, suggest fusiform enlargement of the cord. Eskuchen in Germany and Piccinnius in Italy hold that it has not proved possible, as was at first hoped, to draw any conclusions from the form of the shadow cast by the lipiodol as to the relation of the lesion to the meninges and cord or as to the pathological nature of the lesion. Supporting the last statement, that a pre-operative pathological diagnosis cannot be made from the roentgenologic data after injection of lipiodol, the following case is presented. The history was not typical of tumor of the spinal cord but suggested an inflammatory lesion. The normal spinal fluid, however, eliminated this possibility so that even in the presence of a definite level of sensory disturbance and in the absence of a response to jugular pressure, lipiodol was used to attempt a differentiation of the underlying pathological process.

Case 3. A man aged 25 years registered at The Mayo Clinic October 16, 1927, complaining of paralysis of both legs. He had apparently been well until 1923, 4 years previously, when pain in the upper part of the spine, radiating into the inguinal region, came on suddenly; within 2 weeks after the onset of pain, his legs became weak, and after a month he was unable to walk; he recovered from this within another month, but in August, 1926, 3 years after the initial onset, the backache returned; the pain was worse with activity and was relieved by rest. Weakness of the lower extremities developed and for 5 weeks previous to admission, he was unable to walk because of it; between the attacks, the gait had been normal although the patient thought that subsequent to the original attack he had never recovered the full strength of his legs. Roentgenologic examination of the spine was negative. There was marked spasticity of both lower extremities, with a level of sensory disturbance corresponding with the tenth and eleventh dorsal segments. There was increase of patellar reflexes on both sides, with loss of the tendon of Achilles reflex on the right; bilateral ankle clonus was present and abdominal reflexes were abolished; bilateral positive Babinski could be elicited. Exami-

nation of the spinal fluid revealed negative Kolmer and positive Nonne tests, and normal color. There was no response to jugular pressure. In view of the confusing history and in spite of the lack of response to jugular pressure and the definite level of sensory disturbance, injection of lipiodol was considered advisable for differential diagnosis. Two cubic centimeters of lipiodol radiologique descendant, N.N.R. were injected into the cisterna cerebellomedullaris and its descent was observed under the fluoroscope. When the lipiodol had descended to the level of the eighth dorsal vertebra, there was a definite block and a definite dome-shaped shadow. A roentgenogram made 12 hours later showed the dome-shaped obstruction opposite the eighth dorsal vertebra (Fig. 4). Laminectomy was performed and enlargement of the cord was found, opposite the eighth dorsal vertebra. At first this was thought to be an intramedullary cord tumor; when it was viewed from the anterior aspect, it was seen to be cystic and on being opened, it was found to contain yellow fluid. It was emptied and curretted, and the wound was closed. The patient made an uneventful convalescence, but his condition was not materially improved after operation.

The neurologist is often confronted with the task of making a differential diagnosis of an inflammatory lesion or of a tumor of the spinal cord, and there is often a great deal of difficulty in making such a differentiation. Very few cases of lesion of the spinal cord afford clear cut histories and typical results of neurologic examination. In the following case, there was a rather difficult history and indefinite results of neurologic examination, associated with a positive Queckenstedt test. Although the cell count was 28 lymphocytes in each cubic millimeter and the Nonne test was positive, there was no other evidence that the disease was of an inflammatory nature; consequently, lipiodol was used in an effort to determine the underlying pathological process. Since the lipiodol descended in the subarachnoid space, and opposite the eighth thoracic vertebra separated and descended in two streams, the presence of a tumor of the spinal cord could not be ruled out. In fact, in view of the lack of response to jugular pressure, the presence of an intramedullary tumor was suggested and lipiodol was used to indicate the definite level of the disorder.

CASE 4. A married woman, aged 29, came to The Mayo Clinic March 22, 1927, complaining of pain in the back which had been present for 20 months. In August, 1925, when the patient was 2 months' pregnant, she began to have a dull pain in the sacro-iliac region at night; relief was obtained by getting up and, as a result, she would sleep propped up in a chair. In September, 1925, she began to have flashes of pain down both legs, for a half hour at a time; relief for 2 or 3 hours would follow the periods of pain. The pain continued until June, 1926, when that in the leg disappeared although the pain in the back persisted; the patient also noticed numbness of both lower extremities which began with the onset of pain and which progressed insidiously until the time of admission. Roentgenologic examination of the spine was negative. There was loss of strength of the muscles of the right lower extremity. Both tendon of Achilles reflexes were abolished; there was rather marked inco-ordination of both extremities; a level of sensory disturbance could not be determined. Examination of the spinal fluid showed negative Kolmer and positive Nonne reactions; the color was yellow and there were 28 lymphocytes in each cubic millimeter. There was no response to jugular pressure. In view of the history and indefinite level of sensory disturbance, as well as the lack of response to jugular pressure, lipiodol was advised for the purpose of differentiating the type of lesion, as well as for establishing the level of the lesion. Two cubic centimeters of lipiodol was injected into the cisterna cerebellomedullaris and was seen to descend until, opposite the level of the fifth thoracic vertebra, the lipiodol separated and descended in 2 streams to the level of about the eighth thoracic vertebra. Roentgenograms confirmed this (Fig. 5). Laminectomy was performed, and diffuse leptomeningocystic myelitis of the dorsal portion of the cord was found extending as high as the fourth dorsal vertebra and as low as the eighth dorsal vertebra. The arachnoid, pia mater, and cord were adherent, presenting a grayish appearance, with tortuous veins running through the mass. On splitting the cord dorsally, a simple cyst containing brownish-yellow fluid was found and the fluid was aspirated. The cystic cavity extended from about the fourth dorsal vertebra to about the end of the cord, so far as could be made out. The patient's convalescence was uneventful and she showed slight improvement at the time of dismissal.

The fifth case in the series is an excellent example of the use of lipiodol in cases of questionable lesion of the spinal cord. Its use here consisted in the elimination of definite compression of the cord in the face of an indefinite level of sensory disturbance and slow return to normal following the application of jugular pressure during spinal puncture. The lipiodol descended in the subarachnoid space without interruption, and operation was resorted to only in an effort to demonstrate a definite lesion which might be relieved by laminectomy. The case only intensifies my impression

that lipiodol has its uses in eliminating a possible lesion when other data are confusing.

CASE 5. The patient reported at The Mayo Clinic March 9, 1928, complaining of increasing difficulty in walking, a sensation of constriction around the trunk and ankles, and numbness and tingling of the lower extremities. He had been in good health until January, 1927, when he began to notice numbness and tingling in both feet and legs and, at about the same time, the gait became unsteady and the legs and feet became more susceptible to cold. These symptoms had progressed slowly until 7 months later, when he had noticed a constricting sensation, as though a band had been laced about the lower part of the abdomen. At the same time, he noticed difficulty in urination and in defæcation. In January, 1928, a sharp shooting pain developed about the precordium. Urinalysis showed specific gravity 1.024, acid reaction, and a slight amount of pus. The blood count was normal and the Wassermann reaction of the blood was negative. Roentgen-ray examination of the spine did not show any demonstrable lesion. Neurological examination elicited a definite decrease in tonus and speed of reaction of the muscles of both lower extremities, with increase of both patellar and tendon of Achilles reflexes. There was loss of both epigastric reflexes; positive Babinski and Chaddock reflexes were present bilaterally and there was definite inco-ordination with spastic gait and a positive Rhomberg sign. Examination of the spinal fluid demonstrated a negative Wassermann reaction, a positive Nonne reaction, normal color, and negative microscopic appearance. There was prompt response to jugular pressure, but very slow return to normal. An indefinite level of sensory disturbance could be fairly well determined, the upper limits of which were at the level of the eighth dorsal segment. In view of the history of slow progression, the indefinite evidence concerning the level of the disturbance, and the slow return to normal after jugular pressure, a diagnosis was made of lesion of the spinal cord and injection of lipiodol was instituted as a confirmatory measure. Lipiodol in the amount of 2 cubic centimeters was injected into the cisterna cerebellomedullaris and under the fluoroscope was observed descending in the subarachnoid space; it went down without interruption, passed the site of the suspected lesion, and collected below in the dural culdesac. In spite of the negative roentgenological data, exploratory laminectomy was performed and a diffuse inflammatory lesion was found. A tumor could not be demonstrated.

The use of lipiodol, as emphasized in the foregoing cases, has been an aid to complete general and neurologic examinations in making a differentiation between confusing lesions of the spinal cord as well as serving as an indicator for surgical procedures. In contrast, there are certain cases in which the injection of lipiodol is not only unnecessary but is also contra-indicated, and the following cases illustrate the superfluous application, as well as the deleterious effect, of this medium. As already mentioned, authorities have emphasized the fact that lipiodol acts as a foreign body stimulating an inflammatory reaction of the meninges. The first case in the series, demonstrating the abuse of lipiodol, exemplifies that limitation to its use. This case came under observation shortly after lipiodol had been injected elsewhere; collaboration was made with the original examiner and the results of spinal fluid investigation were compared. A definite inflammatory reaction of the meninges was demonstrated which gradually disappeared during the time of observation at the clinic. The history was one of an inflammatory condition; there was not, at any time, a lack of response to jugular pressure and there was a definite exacerbation of symptoms following injection of lipiodol.

CASE 6. A man, aged 56 years, reported at The Mayo Clinic complaining of paralysis of the lower extremities and numbness of the feet and toes. He had been in excellent health until a year previous to registration when he had caught a severe cold and subsequently influenza had developed. He had apparently recovered from the influenza but a month later a severe generalized headache had developed which often waked him from profound sleep; 2 months after the attack of influenza, he awakened one morning with paralysis of the distribution of the seventh cranial nerve on the right side, following which the headaches ceased. Examination at this time, including examination of the eyes, was negative. The paralysis of the right seventh cranial nerve gradually disappeared after a week and the patient's general condition remained good until about 8 months after the influenza, when he suffered from severe abdominal pain, began to have difficulty in voiding, and complained of cold feet and numbness of the toes. Immediately following this, marked weakness of the left leg developed; the anæsthesia of both lower extremities had ascended and had involved the perianal region. The condition remained stationary for 2 months, when he suddenly noticed severe pain in the right lower extremity, followed by loss of motor function. At this time, examination revealed a negative Wassermann reaction, absence of knee and ankle jerks, and a bilateral Babinski reflex; there had been loss of tactile sensibility over the anterior portion of both legs, absence of cremasteric reflexes, and decrease of tonicity in both the vesical and anal sphincters. Spinal puncture had been made at this time; the Wassermann and Nonne reactions

had been negative; the fluid was yellow and microscopically it had shown the presence of a few erythrocytes. Lipiodol in the amount of two cubic centimeters had been injected into the cisterna cerebellomedullaris and was seen to descend to the upper level of the fourth lumbar vertebra where it was temporarily arrested but it had passed on down leaving fragments in its wake (Fig. 6). Following injection of lipiodol, the pain had become more intense, weakness of both lower extremities had become more marked, and there had been a definite decrease in tactile sensibility over both lower extremities. At this time, the patient was referred to the clinic with a diagnosis of lesion of the spinal cord. After registration, and 9 days following the injection of lipiodol, another examination of spinal fluid was carried out, revealing negative Kolmer and positive Nonne reactions, 11 large lymphocytes, 276 small lymphocytes, and 1 polymorphonuclear leucocyte in each cubic millimeter; the color was slightly yellow. There was prompt response to jugular pressure. The pain gradually lessened in severity and the patient's physical condition began to improve; but the improvement was so slow that a third spinal puncture was made 19 days later. The cerebrospinal fluid although colorless was slightly turbid; there were negative Kolmer and positive Nonne reactions, 4 large lymphocytes, 139 small lymphocytes, and no polymorphonuclear leucocytes in each cubic millimeter; there was prompt response to jugular pressure. The patient gradually became better and was permitted to return home. Four months after dismissal, he was able to walk without assistance although there was still urinary retention.

Ebaugh, in his experimental studies, demonstrated that the systemic effects of the introduction of iodized oil into the subarachnoid space, such as pain in the legs, were transitory. Forestier has maintained that any severe sequelæ are not due to lipiodol but to the puncture alone, justifying his assertion by stating that lipiodol should not be regarded as a permanent foreign body because its absorption is continuous by means of a normal histological reaction. Conversely to these assumptions, the following case illustrates accentuation of pain, severe and lasting, after the introduction of lipiodol. The history, which was essentially one of bilateral sciatic pain, did not point definitely to a lesion of the spinal cord and, in fact, a complete examination was practically negative. Lipiodol was used in an effort to demonstrate or rule out the possibility of a very early tumor of the spinal cord; it descended almost immediately in the subarachnoid space to the lumbar culdesac; the patient complained of increase of pain following the injection and this persisted for several months after his return home, incapacitating him for work. The case demonstrates clearly that lipiodol cannot be used indiscriminately in every case of bilateral pain, or of bilateral sciatica, when other features of the examination do not point to a definite lesion. In the light of the results, conclusions regarding this case were that lipiodol should not be injected in the face of such meager evidence of compression of the spinal cord.

Case 7. A man aged 46 years registered at The Mayo Clinic April 27, 1927, complaining of pain in the back which extended to the left leg, and which had been present for 10 months. Ten years previously, he had had a 3 weeks' attack of steady, rather severe pain, which involved the left sacro-iliac region, the posterolateral part of the left thigh, and the left calf. The pain had cleared up completely in 3 weeks and the patient did not have trouble again until June 1926, when, while loading a wagon, he fell about 6 feet, landing on his feet. The result was severe pain in the left sacro-iliac region, which gradually grew more severe, descended into the left leg, and then involved the right leg; the pain was worse at night and was relieved by getting up and moving about. General and neurologic examinations were carried out. Roentgen-ray examination of the spine was negative. It was noticed that flexion of the head on the chest caused increase of pain. There was mild atrophy and fibrillary twitching of the tendons of the left biceps flexor femoris (external hamstring) and peroneal muscle; there was definite loss of the tendon of Achilles reflex on the right and there was no definite level of sensory disturbance. Examination of the spinal fluid revealed negative Kolmer and positive Nonne reactions and negative microscopic appearance. There was prompt response to jugular pressure. The pain was not relieved by any of the usual methods of treating sciatica and the question of the possibility of a tumor of the spinal cord was considered; consequently injection of lipiodol was instituted. Two cubic centimeters of lipiodol radiologique descendant, N.N.R. was introduced into the cisterna cerebellomedullaris without difficulty; under the fluoroscope, it was observed that the lipiodol descended rapidly within the subarachnoid space and, in a very few moments, the major portion had reached the lower end of the dura, extending from the lower region of the fourth lumbar vertebra to the second sacral vertebra. Roentgenograms, made 12 and 24 hours later, confirmed this (Fig. 7). Therefore, with a history of bilateral sciatica, worse at night, normal spinal fluid, prompt response to jugular pressure, and negative results from the injection of lipiodol, the presence of tumor of the spinal cord was eliminated. However, the patient complained of an increase in pain after return home, with additional pain low in the back and in the lumbar and sacral regions. The

pain resisted all efforts toward alleviation and seemed to increase in severity.

Robineau, after observing 100 cases after injections of lipiodol, was of the opinion that the procedure is harmless, but he modified this statement by saying that it should be subordinate to the clinical examination. One abuse of the procedure of injection of lipiodol is its use in cases in which the clinical investigative procedure suggests a definite inflammatory lesion of the spinal cord. In the following case, the history and examination of the spinal fluid strongly suggested meningomyelitis, but in an endeavor to distinguish a neoplastic from an inflammatory process, injection of lipiodol was carried out. At operation, the lesion was unequivocally inflammatory and appeared to be an acute lesion superimposed on a chronic process.

CASE 8. The patient came to The Mayo Clinic July 11, 1927, complaining of pain which had been present for 3 years in the lower part of the lumbar spine and right leg. Following an operation for chronic appendicitis, 4 years previously, the patient had begun to have severe pains in the back which radiated down the thighs and legs. There had been relief for about a year and then the same pain had reappeared. After a trip West in an automobile, she had almost entirely recovered, but about February, 1927, the trouble had returned and had persisted. An epidural injection of 1 per cent procaine was given and the patient obtained relief for about 12 hours; however, the pain returned and the patient lost considerable weight. The roentgen-ray appearance of the spine was normal. There was absence of localized weakness of the lower extremities. The tendon Achilles and abdominal reflexes were normal bilaterally; a definite level of sensory disturbance could not be ascertained. A spinal puncture was made and there was no response to jugular pressure. The fluid gave a negative Kolmer reaction and was of dark yellow color, coagulated on standing, and the total protein content was 2920. A diagnosis was made of unlocalized lesion of the spinal cord, probably inflammatory, and in view of the doubtful history and positive Queckenstedt test, as well as the coagulation of the fluid, injection of lipiodol was advised. Lipiodol in the amount of 2 cubic centimeters was injected into the cisterna cerebellomedullaris and was observed under the fluoroscope to descend and then to stop at the lower border of the eighth dorsal vertebra. The shadow cast by the iodized oil, as seen by the roentgenogram, was not characteristic of a tumor of the spinal cord but was funnel-shaped, giving the impression of an inflammatory lesion (Fig. 8). Exploratory laminectomy was performed, at which time the spines and laminæ from the seventh and eighth dorsal vertebræ were removed, thus exposing a diffuse area of meningomyelitis. A definite inflammatory reaction was observed, after incision of the dura, with multiple cysts containing thick yellow fluid; the entire inflammatory process appeared to be acute and superimposed on a chronic lesion probably induced by the lipiodol. The patient's convalescence was without incident but she did not show any definite improvement following the operation.

This case shows that in chronic inflammatory lesions of the spinal cord, lipiodol, by its irritative action, may set up an acute inflammatory reaction superimposed on the lesion.

One more case in the series was selected as an example of abuse of iodized oil, because it not only demonstrated that an inflammatory reaction is produced around a tumor by lipiodol but, in view of the unfortunate termination of the case, it raises the question of the possibility of a systemic reaction. In retrospect, it seems possible also that lipiodol was used in this case as a short cut and was not subordinated to the clinical investigation.

CASE 9. The patient came to The Mayo Clinic November 17, 1927, complaining of occasional attacks of pain which had persisted for 3 years and which had been limited to the small of the back. In January, 1927, a dull pain had occurred which had been localized in the right lower quadrant; one month later, appendectomy had been performed, following which the pain in the back had become much more severe and constant, was worse at night, and radiated along the course of the right sciatic nerve to about the knee. In May, 1927, the patient had noticed definite progressive atrophy of both legs. In October, 1927, after he had had all possible foci removed, he entered the hospital for further treatment. Extension was applied and the patient grew worse; numbness and tingling in the right leg extended up to the knee. General and neurological examinations revealed loss of tactile pain and temperature sense in both lower extremities with preservation of immediate perianal sensation. There was marked atrophy of both lower extremities as well as loss of all reflexes below the hips. Examination of the spinal fluid revealed a negative Kolmer reaction, yellow fluid, which coagulated rapidly, and no response to jugular pressure. Injection of lipiodol had been made about a week previous to registration and roentgen-ray examination of the spine revealed lipiodol which had descended in the subarachnoid space to the level of the third lumbar vertebra (Fig. 9). Laminectomy was advised and carried out, at which time a tumor of the cord, about 2.5 centimeters in length and fusiform in shape, was exposed and removed. Surrounding the tumor were many adhesions to the fibers of the cauda equina and there was a definite acute inflammatory

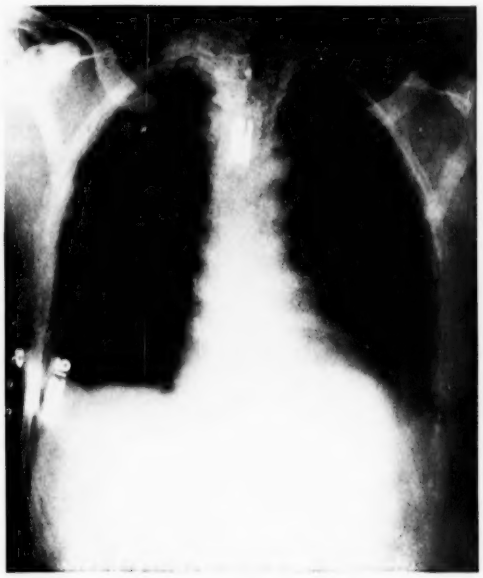

Fig. 1. Injection of lipiodol. Tumor of the spinal cord localized by means of iodized oil in the presence of clear fluid and negative Queckenstedt test.

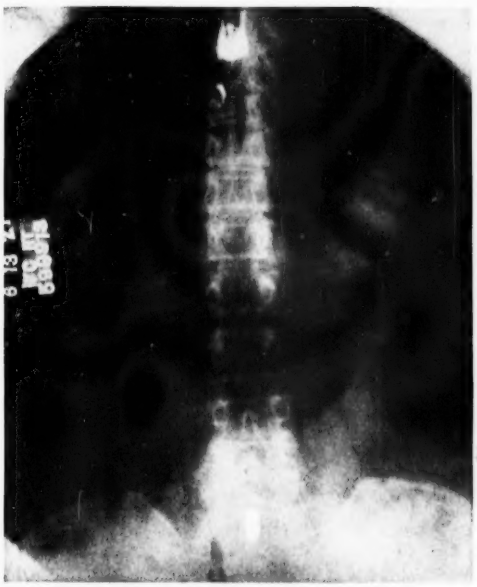

Fig. 2. Arrest of lipiodol above tumor of the spinal cord with some iodized oil in the cul-de-sac; in this case, the cerebrospinal fluid was clear and there was a negative Queckenstedt test.

reaction. The tumor was removed completely, with very little, if any, trauma to the spinal roots. It proved to be an ependymal-cell glioma which had degenerated within its center and had become cystic. The marked inflammatory reaction around the tumor, which involved all of the fibers of the cauda equina, was probably set up by the injection of lipiodol. Following the operation, the patient was returned to his room and, although in a weakened condition from the procedure, was not considered in danger; however, 3 hours afterward, he died suddenly. Necropsy did not reveal a cause for death. The question arises whether the lipiodol could have had anything to do with sudden death in this case.

In the final case, as in the preceding one, the history, the neurological examination, and the spinal puncture, together with examination of the spinal fluid, suggest that probably lipiodol was injected unnecessarily. This case has been selected to demonstrate further that even in view of the successful removal of the tumor, with recovery of the patient, one of the abuses of lipiodol is its injection in the face of a positive history and examination.

Case 10. A man aged 66 years registered at The Mayo Clinic because of paralysis of both legs and pain in the back. Three years previously he had begun to have severe pain in the sacral area; 2 years later, the pain became almost constant, was worse at night, and was relieved by sitting up; the pain increased in severity and, about 6 weeks prior to registration, paralysis of both legs, more marked in the left, suddenly developed. General and neurologic examinations revealed loss of strength and of speed of reaction and tonus of all of the muscles of both

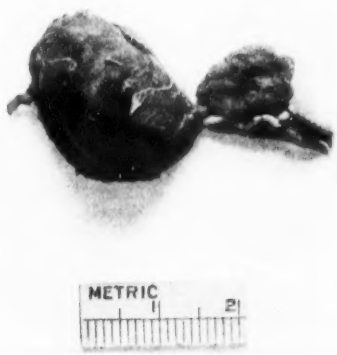

Fig. 3. Intradural extramedullary meningioma.

Fig. 4. Dome-shaped shadow cast by an intramedullary cyst of the spinal cord.

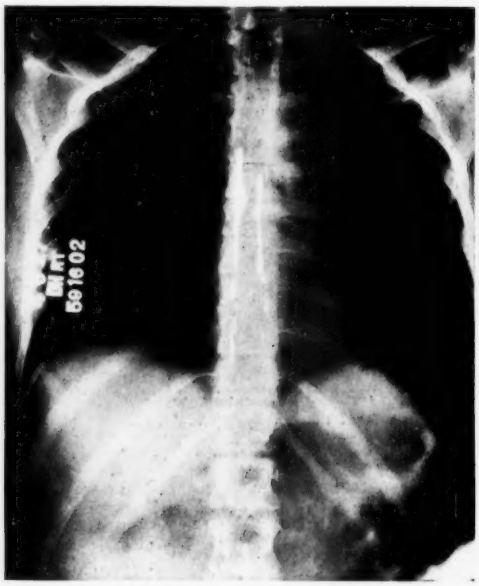

Fig. 5. Descent of lipiodol in two lateral lines in a case of inflammatory lesion.

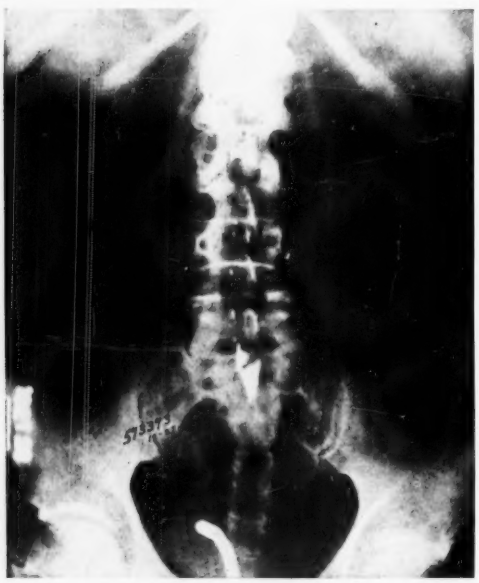

Fig. 6. Injection of lipiodol in a case of extensive inflammatory lesion of the spinal cord in which there was an acute exacerbation and ultimate recovery.

Fig. 7. Injection of lipiodol in a patient suffering with bilateral sciatica with exacerbation of pain.

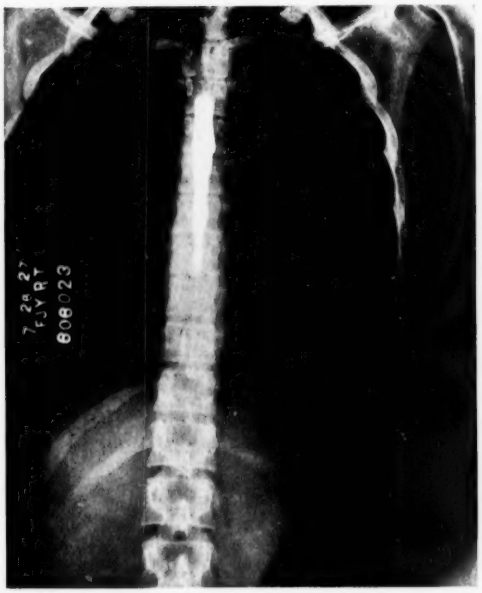

Fig. 8. Injection of lipiodol in a case of diffuse meningomyelitis.

Fig. 9. Injection of lipiodol showing definite localizing signs and inflammatory reaction about the tumor and cauda equina.

lower extremities. Patellar and tendon of Achilles reflexes were abolished. There was definite saddle anæsthesia and loss of tone in the anal and rectal sphincters. Examination of the spinal fluid showed negative Kolmer and positive Nonne reactions; the fluid was yellow-tinged and there was no response to jugular pressure.

A diagnosis had been made elsewhere of tumor of the spinal cord and, a week previous to admission, lipiodol had been injected and roentgen-ray examination of the spine at the time of examination at the clinic showed the lipiodol opposite the body of the eleventh dorsal vertebra (Fig. 10). Laminectomy was advised and performed; on exposure of the dura, opposite the twelfth dorsal vertebra, it was found to be very tense and the impression gained was that the dural sac was markedly distended with some sort of a mass; on opening the dura, it was obvious that a tumor existed anterior to the conus. On further exploration, a tumor was found which filled the entire lumbar canal besides extending up into the dorsal canal. On exposure of the upper border of the tumor, cloudy cerebrospinal fluid escaped and the entire tumor was surrounded by a flocculent exudate which was causing marked adhesions between the tumor, fibers of the cauda equina, and meninges. The tumor was completely removed and the patient recovered, but the function of the lower extremities and sphincters did not return to normal.

Fig. 10. Injection of lipiodol demonstrating caudal tumor in which there had been a superimposed inflammatory reaction about the lesion.

CONCLUSIONS

Iodized oil injected into the subarachnoid space is an invaluable adjunct in the armamentarium of the neurologist and the neurologic surgeon in diagnosing compression of the spinal cord but it has its use and abuse. This diagnostic procedure should always be employed in conjunction with a complete examination and the results obtained should never occupy more than relative importance in the establishment of a diagnosis; the irritative action on the meninges contra-indicates its use in frank inflammatory lesions. By the use of iodized oil, the presence of tumor of the spinal cord can be detected earlier in certain cases, and the fact that there is a response to jugular pressure does not preclude its use. The outstanding use of lipiodol is for the confirmation of a suspected tumor of the spinal cord, and its greatest abuse is its employment in cases in which a complete examination would have established a diagnosis.

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VARICOSE VEINS—THE CIRCULATION AND DIRECTION OF THE VENOUS FLOW

Experimental Proof

H. O. McPHEETERS, M.D., F.A.C.S., and CARL O. RICE, M.D., Minneapolis, Minnesota

THE subject of disability caused by varicose veins has been given much consideration during the past few years. This is especially true since the advent of the injection treatment by means of sclerosing solutions.

The method of the injection directly into the blood stream of a destructive solution with the idea of producing thrombus formation, which is always regarded as the parent of an embolus, seems unscientific and certainly nonsurgical. It is in the attempt, however, to prove that the direction of the venous flow in varicose veins tends to prevent embolus formation rather than produce it that we have undertaken this bit of experimental work.

Normally all venous flow is upward, both in the superficial and the deep system of veins. The deep veins scattered through the muscles of the lower leg are supported by the surrounding muscles and strong fascial layers. This prevents the walls from giving way and producing varicosities. The action of these muscle layers tends to collapse these veins, thus forcing the contained blood upward with a pump-like action. The veins of the superficial group, however, have no support other than their own walls and that of the surrounding fascia which is mostly soft adipose tissue. The fat offers but little support to the vein walls and at times practically disappears. The skin, while possessing the turgor of youth, does not prevent the veins from dilating in the fatty layers and becoming elongated and tortuous. In later life even this tonicity of the skin is lost and the veins often become but little more than large saccules of stagnant blood. Whether the primary factor in the etiology here is the loss of the valve function (2) or an injury to the vein wall from infection (2) permitting the vessel to dilate and throw extra stress on the valves in the saphenous vein, is a much debated question.

It is our contention that in all varicose veins, and particularly in those in which valve action has become deficient either through a primary destructive injury to the valve or secondary to a dilatation of the vein walls, the venous blood is stagnant or flows in the reverse direction. Particularly is this true in those veins in which the result of the Trendelenburg test with von Perthes modification is positive or double (Fig. 7).

This phenomenon—Trendelenburg sign—merely demonstrates that the valves of the saphenous vein are incompetent (Trendelenburg positive); or that the valves in both the saphenous and in the communicating vein are incompetent (Trendelenburg double) and, furthermore, that the deep saphenous system is competent and functioning.

In his thesis Bernstein (1) has shown that in the early and beginning varicosities the Trendelenburg sign is nil in 71 per cent; in the advanced or moderately advanced cases, the Trendelenburg sign is positive in 40 per cent; and nil in 30 per cent. We, however, have been unable to confirm Bernstein's findings of 71 per cent Trendelenburg nil in early varices, although we have seen a few such cases.

Practically all of our cases, although many of them had small varices, have shown a Trendelenburg positive, negative, or double sign. These findings indicate that the incompetency of the valves is not the sole causative factor in the production of varicosities. Bernstein has also proved, by an extensive examination of gross specimens of varicosed segments removed at operation, that his demonstrations of the various Trendelenburg signs were founded on pathological findings.

It has been our aim to demonstrate and confirm these findings in the living subject. With the aid of the fluoroscope we believe that we have been able to do so.

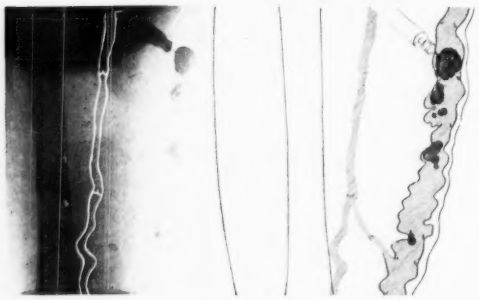

Fig. 1. The second injection of 1 cubic centimeter of lipiodol about the point of the needle with the first 0.5 cubic centimeter progressing down the saphenous vein after repeated straining. As long as the patient was motionless the globules remained stationary.

ANATOMY AND PHYSIOLOGY

The normal anatomy of the superficial and deep veins is well described in any standard textbook of anatomy.

The salient features in relation to the subject in question may be of interest here. The deep veins are placed among the muscles of the leg; thus their vein walls are well supported. The muscular contractions of the leg in walking exert a constricting effect on the veins of the deep system and with a pump-like action force the blood upward in these veins, which are equipped with valves to prevent a reverse flow. The superficial veins lie in the superficial fascia just under the skin with nothing more for support. They, too, are equipped with valves. To aid in the expulsion of blood from these veins, there are the valves plus the aspiratory effect of respiration, as described by Bernstein (1) and Hallion (3), and the aspiratory action of the pelvic veins. Between the superficial and the deep veins are the anastamosing communicating veins likewise equipped with valves facing in the direction of the deep circulation. Thus in a normal person it is possible for the blood to pass from the superficial veins to the deep system but not ordinarily in the reverse direction. If the Trendelenburg sign is negative or double, this reverse flow from the deep to the superficial system will be possible.

In the normal person there are three things which aid in the progress of the blood from the veins of the lower extremities: (1) the muscular activity of the legs with its contractile effect which forces the blood upward; (2) the negative pressure within the abdominal cavity which is produced by the raising of the diaphragm in expiration and which tends to aspirate the blood from the lower extremities; and (3) competent valves which prevent the onward flow of blood from dropping back.

PATHOLOGICAL

The exact etiological factor in the production of varicose veins is not yet definitely determined, nor do we believe that one single factor will ever be found to be the sole cause. We believe that a hereditary tendency is a prominent predisposing factor and that a low grade infection of the vein wall plays a great rôle in many cases. We do not fail to recognize the influence of glandular changes, occupational stasis, intra-abdominal tumors, and pregnancy, although in most of these we have been able to trace a hereditary tendency or focus of infection.

For convenience we have arbitrarily designated four different sizes of varicose veins.

Size	Diameter in centimeters
1	Up to 0.5
2	From 0.5 to 1
3	From 1 to 1.5
4	1.5 to 2 or more

Those varices larger than 2 centimeters are usually aneurismal and saccular in type.

In varicosed veins, as in any other pathological condition, it is natural to presume that the normal function is disturbed, and the

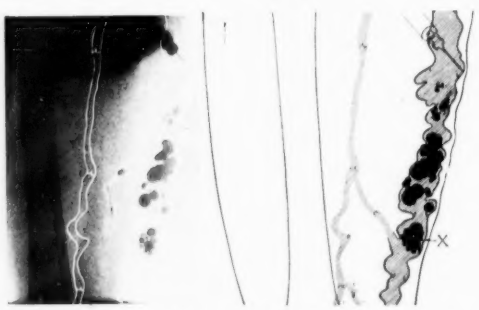

Fig. 2. The lipiodol is passing down the saphenous vein under the force of mild abdominal exercise and passive movement of the leg.

more extensive the disease the greater the disturbance in function.

In beginning varicosities 71 per cent have competent valves according to Bernstein's figures. We presume, however, that the aspiratory effect upon the blood in the enlarged varicosed vein is not sufficient to draw this greater volume of blood from the enlarged vein; rather, it would be easier for the blood to pass through the communicating and into the deep veins where the flow is more normal as is demonstrated by the Trendelenburg positive, double, or negative sign, or to remain practically stationary as in the Trendelenburg nil sign gradually draining backward through the valves as the pump-like action of the muscles on the deep veins forces the blood out from the veins below. As the veins become more dilated the valves become less effective and the reverse flow more pronounced. The positive intra-abdominal pressure during inspiration tends to retard the flow of blood from the superficial veins and later, after the valves have become incompetent, actually to increase the reverse flow.

We have observed under the fluoroscope that inspiration caused a definite reflux in a saphenous vein where the valves were incompetent but that expiration, contrary to what we originally anticipated, caused no aspiratory effect in the enlarged varicosed veins, whereas in the deep set of veins this aspiratory effect was definitely in evidence. We have also observed under the fluoroscope that muscular exercise produced a definite pump-like action,

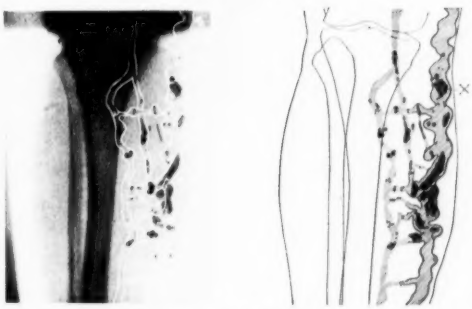

Fig. 3. The globules of lipiodol are seen in the leg passing from the superficial into the deep system, through the communicating veins. This is the result of active exercise of the leg muscles.

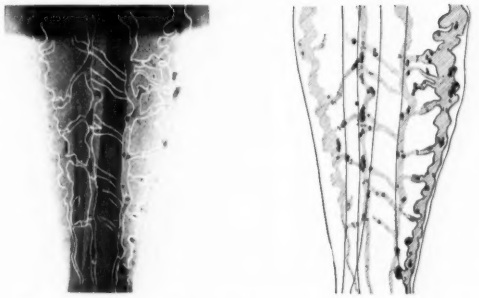

Fig. 4. After further active exercise the globules are seen to scatter widely throughout the deep system of veins and are progressing centralward through the deep veins. None was seen to pass upward through the superficial saphenous veins.

drawing the blood from the superficial varicosed veins through the communicating veins and forcing it upward through the deep saphenous system. None was seen to pass up through the superficial saphenous vein.

The following cases which have been studied under the fluoroscope will clearly demonstrate our contention:

CASE 1. The patient had had varicose veins (size 4) for 10 years. They caused her considerable discomfort. The veins extended from the midportion of the thigh to the ankle in a continuous tortuous mass of varicosities. The Trendelenburg test showed a positive sign with von Perthe's modification, indicating that the valves of the superficial saphenous were incompetent but that the valves in the communicating and deep veins were functioning, so that during muscular exercise of the leg the blood from the superficial varicosed veins was pumped up through the deep circulation.

With the aid of the fluoroscope we attempted to determine the course of the injected fluid in the saphenous veins. We injected 1 cubic centimeter of lipiodol into the upper limit of the varicosed saphenous vein and then observed its progress under the fluoroscope, taking X-ray exposures at various stages. We have outlined the saphenous vein on the X-ray plates so that it can be more readily identified.

The first fluoroscopic exposure was made with the patient relaxed in a reclining position and showed the lipiodol being injected from the point of the needle. While the patient remained quiet the solution remained stationary about the point of the needle. She then raised her head and with this small amount of exertion of the abdominal muscles and consequent increase in intra-abdominal pressure the solution was seen to break up into several particles and move quickly downward. With the relaxation of her head, the fluid was seen to fluctuate back. Repeated raising and lowering of the head caused

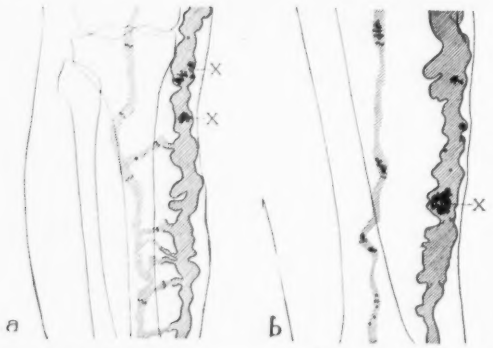

Fig. 5. Repeated movements of the leg and expiratory exercises have drawn most of the globules upward through the deep system of veins, with only small groups of globules remaining. The group marked *x* appeared to be confined in an aneurism along the course of the main veins, where they swirled about on active exercise.

the globules of lipiodol to break up into numerous particles and to pass farther downward below the knee joint.

She was then asked to raise her body into a semi-reclining position. With this motion, the solution passed down the entire length of the saphenous vein. This demonstrates the reverse flow produced by the increase in intra-abdominal pressure alone. Repeated exercises of the abdominal muscles as described above succeeded in producing only a to-and-fro motion of the particles of lipiodol in the superficial saphenous vein and did not tend to make the particles pass through the communicating and into the deep circulation. We then had her move her toes and ankle back and forth, thus producing exercise without force. With this motion we saw the globules of lipiodol dash into the communicating veins where they fluctuated back and forth with

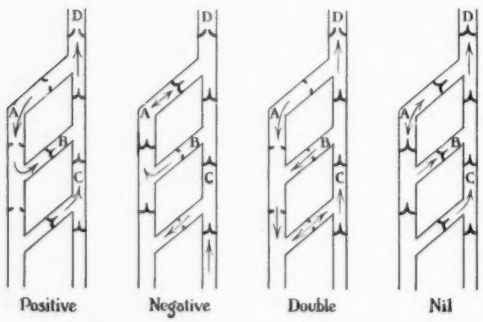

Fig. 7. Diagrammatic sketches illustrating the condition of the valves in the various Trendelenburg signs as described by Bernstein. Note the direction of the venous flow. *A*, Superficial saphenous vein; *B*, communicating veins; *C*, deep system of vein; *D*, femoral vein.

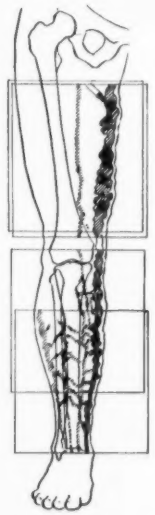

Fig. 6. A composite drawing of Figures 1 to 5.

each motion, but they did not flow toward the heart until forceful exercise was produced by pushing the foot against the examiner's hand to simulate the muscular action of walking. During this exercise the globules of lipiodol were seen to move gradually centralward with each muscular exertion until finally they had disappeared completely by way of the deep veins of the leg. None was seen to go up through the superficial saphenous vein.

A similar experiment was carried out with Case 2 and as the plates in the case are typical of both cases we are using them to avoid duplication.

CASE No. 2. Mrs. H. F., age 40, had large varicose veins (size 4) extending from her groin to the ankle in a continuous tortuous mass of varicosities. Trendelenburg sign was positive with von Perthe's modification. The patient was placed upon the fluoroscopic table in the sitting position with her legs extended horizontally. One-half a cubic centimeter of lipiodol was injected into a large loop of vein in the upper third of the thigh and its progress observed under the fluoroscope, pictures being taken at opportune intervals.

As long as the patient remained perfectly quiet, the lipiodol remained in a solid mass about the point of the needle (Fig. 1). She was asked to strain as at stool, producing a definite increase in intra-abdominal pressure. The globules of lipiodol passed downward about 6 inches (Fig. 2). Relaxation caused no reflux. Further straining scattered the globules and forced them farther peripheralward. One cubic centimeter more of lipiodol was injected

and the same procedure produced similar results (Fig. 1). Muscular activity of the foot without force caused the particles of lipiodol to pass downward into the veins of the leg and into the communicating veins where they were seen to swirl around in aimless fashion (Fig. 3). One particle appeared to be caught in an aneurismal sac for it remained twirling constantly in one place as seen in all the plates in the mid thigh (see *x*, Fig. 5). Forceful exercise of the calf muscles, pushing against the resistant hand of the examiner, in simulation of the action of walking, caused the particles to pass into the deep system where they advanced toward the heart with each pump-like action of the leg (Figs. 3, 4, 5).

During inspiration the globules in the superficial varicosed saphenous veins were forced peripheralward about 1 inch. Those globules in the deep system remained stationary. This was the effect of intra-abdominal pressure upon the valveless saphenous vein. Expiration with its negative intra-abdominal pressure produced no change in the superficial varicosed saphenous vein but tended to draw the particles centralward from the deep system of veins due to its aspiratory effect. With repeated expirations we were able to aspirate the particle of lipiodol farther centralward through the deep system of veins, but this had no effect upon the particles of lipiodol in the superficial veins.

We presume that the greater volume in the varicose veins is not influenced by the aspiratory effect within the abdomen during expiration. The blood, therefore, follows the path of least resistance and passes downward through the communicating into the deep veins and then centralward where the physiological factors are more normal.

CONCLUSIONS

We believe that these experiments demonstrate and confirm the findings of Bernstein, which he obtained through extensive operative work in the surgical treatment of varicose veins.

In the early cases of varicose veins of the legs the valves in the saphenous vein may be competent and there is no reverse flow. In these there is merely a stagnation of blood. These demonstrate Trendelenburg nil.

In the moderately advanced cases the valves have become deficient and the Trendelenburg test sign is positive with the blood flowing downward in the superficial saphenous and into the deep veins through the communicating veins, the valves of which are still normal.

In the advanced cases the valves in the communicating veins are also destroyed and the Trendelenburg sign is double.

This explains clearly how valvular incompetency in the great saphenous (Trendelenburg positive) plus the valvular deficiency in the communicating veins (Trendelenburg negative) gives the condition described as Trendelenburg double. In this condition we get a reverse flow from both the superficial and deep system of veins causing a stagnation of blood in the dependent extremity with a saturation of the tissues by blood serum. It is this saturation of the tissues that lowers their resistance and makes them so susceptible to infections and later ulcer formation, the dreaded end-result of varicose veins.

We believe that in all varicose veins of the lower extremities, the circulation is either stagnant or reversed and that the chemically induced thrombus is forced distally toward the smaller and branching veins where it will most certainly be arrested.

We believe that until some more definite reason can be found to account for the rare development of emboli, we must accept this as an explanation of their unusual occurrence.

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THE BEHAVIOR OF GASTRIC ACIDITY IN DUODENAL ULCER AND PYLORIC OBSTRUCTION BEFORE AND AFTER GASTRO-ENTEROSTOMY

ROBERT ELMAN, M.D., St. Louis
From the Department of Surgery, Washington University School of Medicine and Barnes Hospital

THOUGH the behavior of gastric acidity in duodenal ulcer is of practical as well as theoretical importance, and a great many studies have been made thereof, the factors governing it are still largely undefined. The assumption has been generally made, on purely theoretical grounds, that the so-called hyperacidity frequently found in these cases is due to hypersecretion and that for some reason the gastric glands produce a juice of higher acidity than normal. Yet we have no evidence that such is the case. Indeed, the acidity of pure actively secreted juice is quite constant and, according to Pavlov and confirmed more recently by Carlson, never exceeds a value equivalent to 0.5 per cent hydrochloric acid. The most "hyperacid" gastric contents may reach but never exceed this level.

Whatever the cause of high acidity or, indeed, variations in gastric acidity in general, it is a widely accepted observation that a lowering of acidity usually takes place following operations for the relief of duodenal ulcer, particularly gastro-enterostomy and gastric resection. Many surgeons (8, 14, 16) have claimed that the success of such operations depends on the development of such a postoperative hypo-acidity or even anacidity. It is, therefore, of the utmost clinical importance to study the mechanism by which this end is achieved. Some explanations have been offered, it is true. As will be pointed out below most of them are untenable.

Variations in the level of gastric acidity in the normal as well as in the diseased stomach are, according to the prevalent view, a matter of variations in the secretory activity of the gastric glands. Much evidence has accumulated in recent years to discount this idea and to support a conception first advanced by Boldyreff in 1911. This evidence has been presented and discussed in some detail in a previous paper (10). In brief, it is assumed that the high and constant acidity of the actively secreted gastric juice is normally reduced to the lower acidity usually found in the stomach contents by some neutralizing mechanism and that this mechanism is one of reflux of the alkaline pancreatic juice into the stomach. Variations in this activity, then, would account for variations in neutralization and, hence, in the level of gastric acidity. Lesions about the pylorus, for example, either by spasm or by actual obstruction by ulceration, would lessen the duodenal regurgitation and thus account for the high gastric acidity so frequently found in these cases. In this paper observations of this sort have been made.

The degree of acidity produced by the stomach after a test meal, therefore, is here of relatively little interest. Countless observations of this kind have already been made in a wide variety of diseases, with many different forms of gastric stimuli, and, as shown by Bloomfield and Keefer, with rather limited value owing to the widely divergent findings among perfectly normal persons. The main object of this study is rather the rapidity and effectiveness with which acid, once secreted, is neutralized in the stomach. The device used to measure this neutralization consists of introducing an acid solution of the strength normally secreted by the gastric mucous membrane (0.5 per cent hydrochloric acid). Samples are withdrawn at intervals for analysis, and the degree and rapidity of its neutralization is thus measured. This acid test meal was originally devised for experimental animals by Boldyreff. It was used by Migay in a patient with a stomach fistula and by Apperly in normal persons.

METHOD

The acid test meal, 300 cubic centimeters of 0.5 per cent hydrochloric acid solution, is introduced into the stomach through a small rubber tube fitted with a perforated metal tip such as is used for duodenal drainage. Samples are removed thereafter and titrated

against one-tenth normal sodium hydroxide for "free" and "combined" acid using Toepfer's reagent and phenolphthalein as end points respectively.

The usual routine for an Ewald test meal is used. Patients are allowed nothing by mouth after midnight preceding the morning of the test. During the test the patient is kept in a sitting position either in bed or in a chair. The tube, previously chilled by immersion in ice, is passed rapidly into the stomach until gastric contents are obtained which usually correspond to a mark on the tubing. This position is maintained during the rest of the test. In a few patients fluoroscopic examinations were made to check the position of the metal bulb in relation to the mark on the tubing to insure the presence of the tip in the most dependent parts of the fundus, since obviously, if the tube passes on to the duodenum, the test is of little value for purposes of this study.

The fasting contents are first removed, the acid solution given, and an immediate sample of 20 cubic centimeters withdrawn. Thereafter 20 cubic centimeter samples are aspirated every 20 minutes until specimens are no longer obtainable, or in any case, no longer than 2½ hours. The initial specimen serves to check the possible presence of unaspirated fasting contents. If its acidity is the same as the original solution it is assumed that no dilution with unaspirated fasting contents has occurred. To insure removal of a fair sample, the syringe is filled and emptied several times, while attached to the tube, to mix the gastric contents thoroughly, and only then is the specimen aspirated for analysis. During the test the patient is instructed to expectorate all saliva so that swallowing of it will not contaminate the test solution. Titrations are carried out on the fasting contents, the initial and all succeeding samples, and their appearance is recorded particularly as to the presence of bile. From the acid values obtained a graph is plotted as will be described.

The acid solution is well borne in all cases, without untoward effect. In one, as noted in the clinical abstract below, a reproduction of the patient's symptoms was provoked. This observation has been made recently by Palmer who gives as a test solution 50 cubic centimeters of 0.5 per cent hydrochloric acid merely to elicit pain, which, if present, he considers of diagnostic value. Since, during the test, a large amount of acid is absorbed, 2 grams of sodium bicarbonate are given to compensate for it, as soon as the test is over.

Observations were first made on a number of normal individuals and on patients with no symptom or sign pointing to disease of the gastro-intestinal tract. Patients with a variety of gastric disturbances were then studied, particularly those with duodenal ulcer, with and without actual pyloric obstruction. The diagnosis in each case was verified by careful roentgenological studies with the barium meal. In case of operation the test was repeated as soon thereafter as feasible and at various times after the patient left the hospital. Gastro-enterostomy was the procedure carried out in every case of duodenal ulcer here considered. Fluoroscopic examinations with the barium meal were made 2 weeks after operation and at intervals thereafter to determine the functioning of the new stoma as well as the presence or absence of 6 hour residue. The cases of duodenal ulcer here presented were not selected; they represent consecutive admissions to the surgical service, most of them having first been studied by the internists and transferred as suitable subjects for operation.

EXPERIMENTAL FINDINGS

The results obtained are plotted graphically, the base line representing minutes after the introduction of the acid and the vertical line the titration values. The "total" acid values are used both in the normal controls as well as in patients with duodenal ulcer, since in nearly every case they parallel the "free" acid.

The normal curves are surprisingly uniform. They are represented together in Chart 1 and are to be compared with the findings in patients with duodenal ulcer, which are shown on the same chart. It will be noted that, in the normal, the graph is nearly straight and that within 80 to 100 minutes the stomach is empty, at which time the final sample has an acid value of between 20 and 40 degrees.

Delayed neutralization in duodenal ulcer and pyloric obstruction. In 9 patients with proved duodenal ulcer (as shown by operation) the type of curve is strikingly different. In them the acid solution is slowly and incompletely neutralized, that is, the curve is more prolonged. The emptying time is delayed, in no case to less than 120 minutes and in many much longer. The most marked delay, as might be expected, is noted in those with pyloric obstruction (cases 11, 13, 16). The final samples show in no case an acidity under 50 degrees; in a few it is as high as 100. The composite results in the 9 cases are represented in Figure 1 for comparison with the normal curves. Brief clinical notes of each case are appended.

The rapid neutralization following gastro-enterostomy. The striking change noted in nearly every case following operation was prompt. In some the acid test meal was given within a week and the neutralization was complete within 60 mintues, the acidity being reduced to zero. Moreover, the samples always contained bile in contrast to the relative absence of it previous to operation. The findings are recorded graphically in Charts 2–7 showing the neutralization curve before and after operation.

Special mention is to be made of one case in which this rapid fall in acidity did not occur (Chart 1, Case 8). Fluoroscopic examination showed a non-functioning stoma, in contrast to the patent opening in the other cases. It is too early yet to determine whether this patient will have a recurrence of symptoms.

DISCUSSION

While the number of cases studied is not large, the findings are uniform and fairly constant. In brief, they indicate a perversion of the gastro-intestinal mechanism in patients with duodenal ulcer, so that, using the acid test meal, neutralization of gastric acidity cannot be accomplished so completely or so quickly as in the normal stomach. This is most marked when there is more or less severe obstruction at the pylorus. The acid solution used as the test meal, moreover, remains in the stomach longer—the emptying time is often prolonged to twice the normal value. Following gastro-enterostomy the mechanism changes almost at once—neutralization occurs very rapidly and completely, and the stomach empties itself of the acid solution in about a third of the time previously necessary. Finally, the gastric contents, free of admixture with bile before operation, now come to contain it constantly.

Certain inferences may be drawn from these findings, particularly since they have an important bearing on the question of the mechanism by which high gastric acidity is frequently maintained in duodenal ulcer and indeed in many cases in which only a pylorospasm can be demonstrated. The presence of the ulcer either actively by spasm, or passively by scar contraction, leads to a dynamic or actual pyloric obstruction thus preventing reflux of pancreatic juice and defeating its purpose as the main neutralizing agent of gastric acidity. It is true that low instead of high acid values are usually found in cases of severe pyloric stenosis. Here, however, a secondary factor has come into play. The gastric retention and dilatation, frequently of long standing, have brought about an atrophy of the gastric mucous membrane which is therefore unable to secrete the high acid juice of the normal glands.

Consideration of the findings herein recorded, moreover, seems to throw some light on the mooted question of the type of operation best designed to develop a permanent postoperative hypo-acidity, which, as seems generally agreed, is clinically the end to be desired in the cure of duodenal ulcer.

The original basis for the operation of gastro-enterostomy was that of drainage, and since duodenal ulcer at that time was probably operated on only when far advanced to the stage of pyloric obstruction, the assumption was a logical one. Even at the present time it is in cases of pyloric obstruction that gastro-enterostomy achieves its most brilliant therapeutic results. It was soon found, however, that in cases with a patent pylorus this explanation did not hold, for gastric contents did not always leave the stomach through the new stoma—as first shown experimentally by Cannon and Blake in dogs and by Schueller and others in humans as well.

In 1907 Katzenstein found that following gastro-enterostomy there was nearly always a lowering of gastric acidity, a finding recorded at about the same time by Willcox and since then repeatedly confirmed by a great many observers (4). Katzenstein maintained that this was the essential effect of gastro-enterostomy and explained it by assuming that bile and pancreatic juice entered the stomach through the new stoma more readily and thus neutralized the gastric acidity more effectively. In support of this contention he presented analyses of the stomach contents in which trypsin, a ferment characteristic of pancreatic juice, was constantly present. Others explained the low acidity after gastro-enterostomy by some sort of reflex inhibition of gastric secretion. The experiments of Steinberg, Brougher, and Vidgoff definitely seem to invalidate this idea. They made a Pavlov pouch and a gastro-enterostomy in a number of dogs and found that the acidity of pure juice from the isolated pouch is always unchanged, though that of the contents of the main stomach is much lower than normal.

Explanations of the mechanism following gastric resection have been quite different. Most observers agree that the gastric acidity following this operation is lower and persists longer than is the case with gastro-enterostomy (4, 28). One meets frequently the statement that this is so because in gastric resection the "acid bearing portion of the stomach" is removed. This is apparently due to a misapprehension, for the pyloric portion of the stomach is really the only part of the stomach which contains *no* acid cells (15). Indeed, its secretion is slightly alkaline (11). To remove the "acid-bearing portion of the stomach" would require a total gastrectomy, for acid cells are found over the entire fundus up to the very cardiac orifice (15). Schur and Plaschkes varied this theory by contending that gastric resection leads to hypo-acidity because the resected pyloric antrum contains the so-called gastric secretin or gastrin, first extracted from the mucous membrane of this portion of the stomach by Edkins. This hormone is supposed to be the normal stimulant of gastric secretion, so that removal of its source, they maintained, diminishes the amount of gastric secretion. Attractive as this explanation is, subsequent evidence has rendered it invalid. Thus, Keeton and Koch showed that gastrin can be obtained not only from the pyloric antrum but is found in even slightly greater concentration in the mucous membrane over the fundus and cardia as well. By direct experiment Steinberg has in another way shown that gastric resection does not inhibit gastric secretion. He found no alteration in the gastric juice flowing from a Pavlov pouch in dogs following resection of the stomach. Portis and Portis performed the same experiment with the same finding.

Evidence of another sort has shown, moreover, that the low acidity following gastric resection is dependent on the intimate communication between duodenum and stomach. If the duodenum, for example, be transplanted so that its contents empty into the lower ileum, the behavior of acid in the stomach after resection suffers a severe change. Steinberg in extensive experiments on dogs, first confirmed the finding of low acidity after gastric resection with the Ewald meal and then demonstrated a very rapid neutralization of an acid test meal. He then transplanted the duodenum into the lower ileum so that pancreatic juice could not readily enter the stomach. The gastric acidity after this procedure was no longer low either in the fasting content or after the Ewald meal, and neutralization of the acid test meal was incomplete and prolonged.

Experimental diversion of the duodenal contents in this way was first used by Mann and Williamson, and the operation was called "surgical drainage of the duodenum." Of especial interest is the finding of Morton that, following this operation, peptic ulceration is very frequent; if pieces of gastric mucous membrane be removed there will develop in the areas thus excised chronic and perforating ulcers, while healing takes place rapidly when the same thing is done in the intact control animal. Unfortunately, no studies on gastric acidity were reported. In our experiments on the total drainage of pancreatic juice, one instance of extensive and severe ulceration of the gastric mucous membrane was

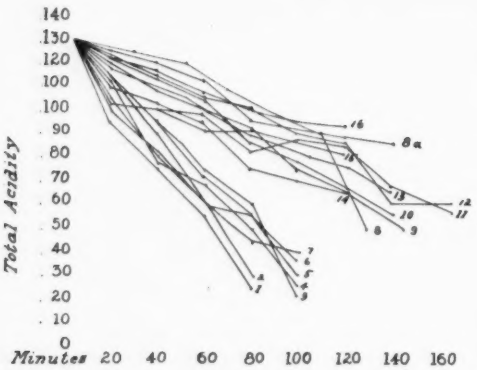

Chart 1. Composite graph showing neutralization curves after administration of the acid test meal in normal controls (lower curves, Cases 1 to 7), and in patients with proved duodenal ulcer or pyloric obstruction (upper curves, Cases 8 to 16).

observed. The entire secretion of the pancreas had been drained to the outside for 6 days before death, and the gastric contents were much more acid than normal (100 to 140 degrees). At autopsy a most remarkable erosion of fully half of the fundus was seen involving all of the mucous membrane down to the muscularis, with tenacious strings of mucus clinging to the edges and a shrinking of the base from muscular contraction. This finding was not repeated, but on going over the protocols it was found that in this case a large stomach tube had been used in obtaining gastric contents, whereas in the other instances a small duodenal tube was employed. The explanation seemed to point to the trauma of the large tube as the obvious cause. More extensive experiments would seem advisable to test the behavior of artificially produced ulcers after removal of the total external secretion of the pancreas.

The surgical problem of duodenal ulcer, then, according to the evidence herein presented, must concern itself with the means best designed to allow pancreatic juice to enter the stomach. Since this takes place through the pylorus it would seem that the surgical attack would best be made at this point. Faulty neutralization occurs because of pyloric obstruction, most commonly a dynamic one due to spasm. Which of the various surgical procedures best promotes neutralization can be determined only by experiment. In the case of many of them, Olch has found that the Finney pyloroplasty best achieves this end, but no clinical studies have as yet been made after this operation, particularly in parallel with cases of gastric resection and gastro-enterostomy, and indeed with the other operations used and advised by various surgeons for the cure of duodenal ulcer.

The cases of gastro-enterostomy herein presented certainly show a prompt and effective reduction of gastric acidity, the "acid test meal" frequently being neutralized completely within 60 minutes and in some within 40 minutes. The one failure, however, indicates that the operation may have more limitations than is supposed. All of our patients are being traced and examined from time to time as to the patency of their stoma, the rate of acid neutralization, and clinical freedom from symptoms. According to Bohmannson who has reviewed the literature, postoperative hypo-acidity following gastro-enterostomy is not permanent. Devine, who has followed up many cases of gastro-enterostomy, has noted that a number suffer recurrence of symptoms and that all of them on examination show a return of the hyper-acidity found before operation. There is a great deal of variability in all reports on gastric acidity, part of which may be due to the variety of gastric stimuli used as test meals. But they all aim to measure the acidity developed in the stomach after a given stimulus. From the evidence reported herein the more important factor would seem to be the measurement of the rate of acid neutralization by means of the acid test meal described. With it a different, and, it is believed, a more valuable picture of gastric physiology in the various operative procedures can be obtained. Further observations along this line are now in progress.

CLINICAL ABSTRACTS

Normal Controls

CASE 1. Male, aged 33 years. No gastric or other complaints.

CASE 2. Male, aged 52 years. Vague epigastric distress of indefinite nature. X-ray showed questionable filling defect in pars pylorica. Laparotomy

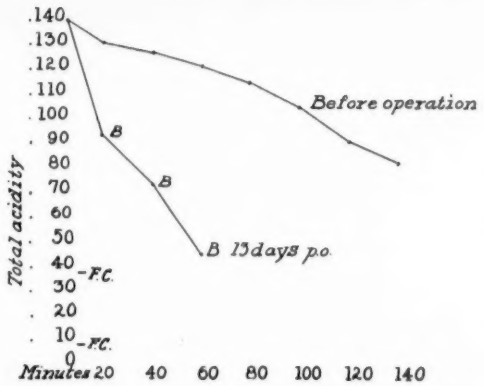

Chart 2. Case 10. Pyloric obstruction. Neutralization curves before and after gastro-enterostomy. Presence of bile, *B*, in stomach and decrease in acidity of fasting contents, *F. C.*, following operation is also indicated.

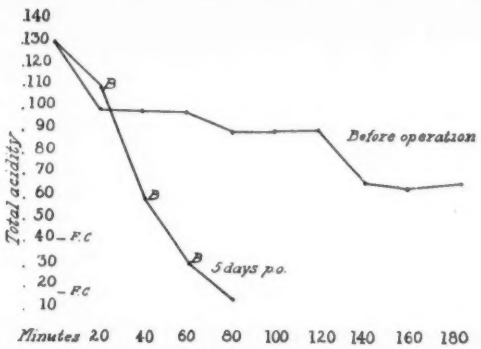

Chart 3. Case 11. Pyloric obstruction. Neutralization curves before and after gastro-enterostomy. Presence of bile, *B*, in stomach and decrease in acidity of fasting contents, *F. C.*, following operation is also indicated.

revealed nothing abnormal. Gastrotomy showed no lesion of interior of stomach. Recovery uneventful.

Case 3. Male, aged 27 years. Hernia of several years duration.

Case 4. Female, aged 42 years. History of pain and discomfort in right upper quadrant. Cholecystectomy for chronically inflamed gall bladder was performed. Stomach found normal at operation and by X-ray.

Case 5. Male, aged 36 years. Central nervous system lues with no active symptoms at present.

Case 6. Male, aged 30 years. No gastric or other complaints.

Case 7. Male, aged 25 years. Hernia of 2 years' duration.

Duodenal Ulcer and Pyloric Obstruction

Case 8. Female, housewife, aged 33 years. History of intermittent attacks of right upper quadrant, pain every week or two for past 6 years, increasing in severity and associated with tarry stools and attacks of vomiting. X-ray shows deformity of duodenal cap with no 6 hour retention. The cholecystograms were normal. Patient sent home with dietary regimen. Neutralization test at this time (Chart 1, 8) showed no bile in any specimen, no reproduction of symptoms, marked delay in neutralization. Fasting contents were 50 cubic centimeters. Patient returned in 7 months with accentuation of symptoms in spite of the fact that she had carefully followed her dietary regimen. She now had tenderness and sharp pains in the epigastrium. X-ray pictures showed barium outside a deformed duodenal cap indicating perforation, but with no evidence of peritoneal irritation. White blood count 8,000. Acid test meal showed an even greater delay in neutralization (Chart 1, 8a) and this time a marked reproduction of patient's symptoms of pain. One week after admission a gastro-enterostomy was performed. The ulcer was found adherent to the pancreas. The gall bladder and liver looked normal. Neutralization tests 5 days and 14 days after operation showed no change in the curve. Barium fill-up showed that stoma was not functioning. Symptoms seemed relieved on discharge from hospital but has not been heard from since.

Case 9. Male physician, aged 28 years. History of several years of epigastric distress and pain, relieved by soda and food. X-ray diagnosis of duodenal ulcer 2 years ago. There has been some relief with dietary treatment but still has occasional discomfort after meals. Acid test meal caused no reproduction of symptoms, no bile in specimens, fasting contents of 25 cubic centimeters. Moderate delay in neutralization (Chart 1, 9). Appendectomy 5 months later at which time the pylorus was searched for and seen with some difficulty without making out any evidence of ulcer.

Case 10. Female, housewife, aged 59 years. History of bloating, belching, pain in right side for 20 years, associated with attacks of vomiting which became severe in past few weeks. On admission she was dehydrated and undernourished. X-ray showed a small duodenal cap contracted and deformed with moderate 6 hour retention. Cholecystogram showed no shadow. Patient discharged with dietary instructions. She was readmitted to the hospital 1 month later with the complaint of constant vomiting for past week. Neutralization test showed 220 cubic centimeters fasting residual (total acidity 35), no bile in any sample, and marked delay in neutralization of acid test meal (Chart 2). Operation was performed 2 days later and a contracted gall bladder, which was firmly adherent to and obstructing the pylorus, was removed. A gastro-enterostomy was also performed. The postoperative course was uneventful. Acid test meal 12 days after operation showed 10 cubic centimeters fasting contents (total

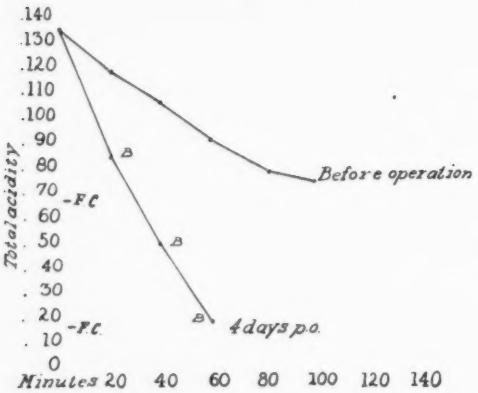

Chart 4. Case 13. Duodenal ulcer. Neutralization curves before and after gastro-enterostomy. Presence of bile, *B*, in stomach and decrease in acidity of fasting contents, *F. C.*, following operation is also indicated.

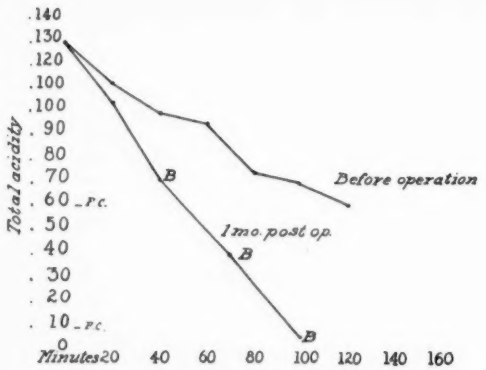

Chart 5. Case 14. Duodenal ulcer. Neutralization curves before and after gastro-enterostomy. Presence of bile, *B*, in stomach and decrease in acidity of fasting contents, *F. C.*, following operation is also indicated.

acidity 0), a rapid neutralization, and bile in all samples. Barium fill-up showed a well functioning stoma with no 6 hour retention. Clinically, patient has remained well.

Case 11. Male, mechanic, aged 52 years. Meager history of gradually increasing vomiting for past 6 months. Two weeks before admission X-ray picture had shown marked 6 hour retention, lengthening and narrowing of duodenal cap. Cholecystogram showed no shadow. After admission an acid test meal revealed pronounced delay in neutralization, with 200 cubic centimeters still remaining after 2½ hours. Fasting residual of 450 cubic centimeters (total acidity 40). The patient was somewhat drowsy and weak, non-protein nitrogen, 166 milligrams per 100 cubic centimeters. Phenolsulphonephthalein excretion 5 per cent in 2 hours. Parenteral fluids were given with high caloric liquid feedings and in 14 days non-protein nitrogen and phenolsulphonephthalein became normal and general condition was markedly improved. At operation 2 days later a small mass was found at the pylorus attached to the pancreas and having a crater at its center. The gall bladder was thickened and gray. Gastro-enterostomy was performed with an uneventful recovery. The acid test meal, 6 days after operation, showed a rapid neutralization (Chart 3) and bile in all samples. Fasting contents were 100 cubic centimeters (total acidity 10). Barium fill-up showed poorly functioning stoma and some retention at 6 hours. Patient was seen 1 and 3 months after operation, showed same rapid neutralization of acid meal, and remained quite free of symptoms.

Case 12. Minister, aged 50 years. History of 2 years' duration with burning and eructation after meals relieved by vomiting. Symptoms were intermittent and were less severe with careful diet. Gastric analysis showed 50 cubic centimeters fasting residual with total acidity of 12. X-ray picture showed moderate 6 hour retention and deformity of duodenal cap characteristic of old quiescent duodenal ulcer. On rest and diet patient improved rapidly. Neutralization test showed definite delay in fall of acid titration and increased emptying time (Chart 1, 12).

Case 13. Salesman, aged 36 years. History of periodic attacks of vomiting of 10 years' duration becoming more and more severe and associated with tarry stools. He has had to be very careful of diet. X-ray examination showed marked retention, obstruction at pylorus, and lengthening and narrowing at the ring. Cholecystogram showed a small, dense, persistent shadow. Neutralization test revealed 120 cubic centimeters fasting residual with total acidity of 64. The acid solution was neutralized incompletely and slowly so that at the end of 2 hours total acid was 90 and 200 cubic centimeters of fluid were still in the stomach. At operation, 8 days after admission, dense scarring at pylorus was found. The stomach was markedly dilated, and the gall bladder looked normal but was attached to the scarred pylorus. A gastro-enterostomy was performed, with good recovery. Five days after operation a small tube was passed into the stomach and only 20 cubic centimeters of bile stained fasting residual was obtained with a total acidity of 20. The acid test meal was given and complete neutralization was effected within 60 minutes, at which time the stomach was empty. Every specimen was bile stained (Chart 3). Barium fill-up 2 weeks later showed a functioning stoma and no 6 hour retention.

Case 14. Janitor, aged 59 years. History of belching, pain, nausea, and vomiting after meals for past 2 years. Attacks have been getting worse although there were weeks of complete relief. Three weeks ago pain became more severe and vomiting occurred every day at 4 o'clock. Gastric analysis revealed 100 cubic centimeters of fasting residual

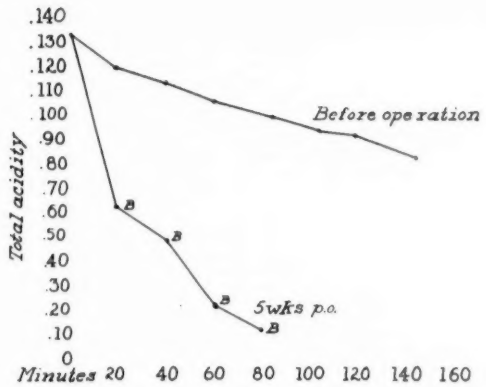

Chart 6. Case 16. Pyloric obstruction and gastrojejunal ulcer. Neutralization curves before and after operation. Presence of bile, *B*, in stomach is also shown.

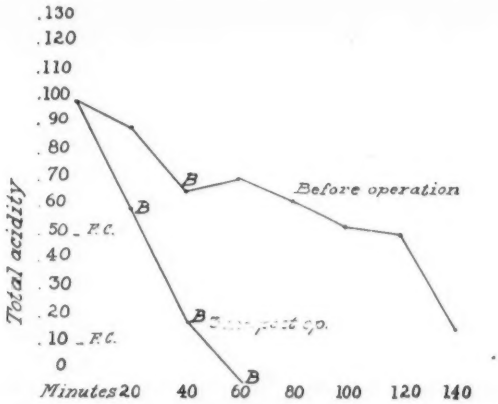

Chart 7. Case 17. Duodenal ulcer, neutralization curves before and after gastro-enterostomy. Presence of bile, *B*, in stomach and decrease in acidity of fasting contents, *F. C.*, following operation is also indicated.

with total acidity of 35. X-ray examination showed marked retention and deformed duodenal cap with lengthening of pyloric ring. The cholecystogram showed a normal shadow. Acid test meal showed marked delay in neutralization and prolonged emptying time (2½ hours). Operation was performed 3 days after admission and a scarred pylorus was found. The gall bladder was normal in appearance. Gastro-enterostomy was performed with an uneventful recovery. The acid test meal 10 days after operation showed a more rapid rate of neutralization which on subsequent tests several weeks later revealed an increasing improvement in this test (Chart 5). Barium fill-up 5 weeks after operation showed freely fuctioning gastro-enterostomy stoma but definite though slight gastric motor insufficiency; moderate gastrectasia persisting.

Case 15. Laborer, aged 28 years. History meager. Pain and discomfort in epigastrium for several years. X-ray picture showed definite evidence of duodenal ulcer which was verified at operation. A gastro-enterostomy was done with recovery but complicated by a moderate wound infection. The acid test meal was given before operation and showed a prolonged emptying time and delayed neutralization (Chart 1). The patient would allow no tests to be made after operation.

Case 16. Male, laborer, colored, aged 51 years. History of pain in epigastrium for past 2 years and of vomiting for past 2 months. Thirteen years before he had had similar symptoms and a gastro-enterostomy was performed for pyloric stenosis due to duodenal ulcer. After freedom from pain for 7 years, symptoms returned and X-ray examination showed a deformity at the stoma suggestive of gastrojejunal ulcer. Relief was obtained with dietary care and gastric lavage until 2 years ago. On admission this time X-ray picture showed marked retention, obstruction at pylorus, a non-functioning stoma, and a deformity in the pars pylorica suggestive of gastrojejunal ulcer. Neutralization test 2 weeks later showed no fasting residual (vomitus of several hundred cubic centimeters recorded previous to test). Neutralization was delayed (acidity reduced from 134 to only 94 in 2 hours) and emptying time prolonged. Four days later operation was performed. A gastrojejunal ulcer perforating into the mesocolon and pancreas was found. The pylorus was occluded by scar. The old stoma was resected, the jejunum was resutured, and a re-anastomosis of the stomach to the jejunum lower down was performed. Recovery was uneventful. Ten days after operation the acid test meal was given. There were no fasting contents, the emptying time was rapid (60 minutes), and neutralization was complete. Bile was present in all samples (Chart 6). Clinical improvement has persisted for over a year and repeated examinations showed the same rapid neutralization, and X-ray examination shows a functioning stoma with no 6 hour retention.

Case 17. Male, carpenter, aged 41 years. History of pain 2 to 3 hours after meals, relieved by food. Frequent tarry stools. Onset 7 years ago and becoming worse. X-ray examination 1½ years before admission showed no 6 hour retention but a deformity of the duodenal cap. A dietary regimen was tried for over a year with no improvement. On admission X-ray picture showed marked 6 hour retention and a gross filling defect in duodenal cap causing obstruction. Cholecystogram was normal. The acid test meal was given and revealed 100 cubic centimeters of fasting contents with total acidity of 50. There was a marked delay in neutralization and increase in length of emptying time. Operation was done 5 days later and showed an indurated ulcer at the pylorus causing obstruction. The gall

bladder was normal in appearance. A gastro-enterostomy was performed with uneventful recovery. Three months later the patient had gained 15 pounds in weight and was free of symptoms. Neutralization test showed an emptying time of 60 minutes and complete neutralization at the end of this time. Bile was present in every sample (Chart 7). Barium fill-up showed functioning stoma and no 6 hour retention.

A note was made that "there seemed to be a mechanical obstruction at the proximal loop resulting in a marked churning phenomenon in the duodenum with constant regurgitation of contents into stomach." This fits in with the specially rapid neutralization. The patient has been seen every 3 months since operation for over 1 year and remains free of symptoms, and the gastric contents have remained hypo-acid.

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CARCINOMA OF THE FUNDUS OF THE UTERUS[1]

LEDA J. STACY, M.D., ROCHESTER, MINNESOTA
Division of Medicine, The Mayo Clinic

THE increase in the incidence of carcinoma of the fundus of the uterus within the last few years has been noted by various writers. The same factors which have played a part, at least, in the increase in carcinoma in general during the last decade apply to the increase in the number of cases of carcinoma of the fundus of the uterus, namely: (1) increase in life expectancy, bringing a greater number to the "cancer age," (2) increased knowledge among the laity of early symptoms of carcinoma of the uterus, and (3) the more frequent examinations of the pelvis and the more accurate diagnoses made by the family physician.

Carcinoma of the fundus and carcinoma of the cervix occurred in a ratio of 1 to 3.4 in a series of 855 cases of carcinoma of the uterus reported by Mahle in 1919. Cullen reported carcinoma of the fundus in 25 per cent of 176 cases of carcinoma of the uterus, and Graves, 22 per cent in 550 cases; in most of the earlier textbooks it is stated that carcinoma occurs in the cervix eight to ten times as commonly as in the fundus.

Carcinoma of the fundus of the uterus has been considered a disease of postmenopause life, but, as in cases of carcinoma elsewhere in the body, recent studies show a greater incidence in younger persons than was shown in earlier reports. Graves considered it "for the most part a disease of atrophy." Three hundred and thirty-three cases of carcinoma of the fundus of the uterus in which operation was performed at The Mayo Clinic between the years 1907 and 1923 inclusive were studied. Two hundred and eleven (63.36 per cent) of the 333 women had ceased to menstruate. One hundred and eighty-six (55.85 per cent) of this number were between the ages of 50 and 59 years inclusive; 64 (19.21 per cent) were between the ages of 60 and 69 inclusive, and 13 were more than 70, the oldest patient being 77. Thirty-five patients (10.51 per cent) were between the ages of 45 and 49 years inclusive, and 35 (10.51 per cent) were less than 45, the youngest being 19. Thus it will be seen that carcinoma of the fundus of the uterus occurs in a fairly large number of women less than 50 years of age.

Uterine myoma or polypi, acting as chronic irritation, may be an etiological factor (as is almost universally believed) in carcinoma of the body of the uterus, for in the group of cases presented here myoma was found during operation in 124 cases (37.23 per cent), and in 12 (3.6 per cent) myomectomy had been performed previously. It is generally conceded that myoma of the uterus occurs in from 10 to 12 per cent of all white women more than 35 years of age. It would seem that the symptoms are masked at times by myoma, as in those patients having symptoms for more than 5 years myoma occurred in 44 per cent, a considerably higher percentage than in those having symptoms for a shorter period. It would seem, too, that the myomata probably developed comparatively late in life, as 216 (72.97 per cent) of the 296 married women had had children, and 14 (4.72 per cent) had had miscarriages. In 31 cases intra-uterine polypi were found at the time of hysterectomy, and in 17 cases (5 per cent) intra-uterine and cervical polypi had been removed previously. It would seem that polypi of the fundus, like those of the rectum, are prone to become malignant in contradistinction to the polypi of the cervical mucosa which rarely undergo carcinomatous change. In this series the carcinoma was on a polypus in 25 cases (7.5 per cent). In 5 cases adenomyoma was found; in one of these the carcinoma was situated on the adenomyoma.

Abnormal vaginal discharge, not bloody, was the first symptom noted in 41 cases (12.31 per cent) and metrorrhagia and watery discharge occurred simultaneously as the first symptom in 47 cases (14.11 per cent). Metrorrhagia occurred in 283 (85 per cent) of the 333 cases and was the first symptom noted by the patient in 212 cases (63.66 per cent). Eighty-one (66.39 per cent) of the 122 women who

[1] Read before a joint meeting of the Chicago Medical Society and the Chicago Council of Medical Women, Chicago, December 12, 1928.

TABLE I.—SUMMARY OF DATA IN THREE HUNDRED SIX CASES IN WHICH A DEFINITE TIME OF ONSET OF SYMPTOMS WAS STATED

Duration of symptoms, years	Patients	Patients traced	Average age, years	Less than fifty years, per cent	Lived more than five years, per cent	Hysterectomy		Per cent.						
						Abdominal, per cent	Vaginal, per cent	With extensive lesion	With associated myomas	With cancer on polypus	Living at last report	Dead at last report	Died of malignancy	Average postoperative life, years
Less than 1	144	126	55.40	23.8	60.30	76.22	23.77	15.8	34.02	15.0	52.38	47.61	39.6	3.06
1–2	70	60	55.02	16.6	66.00	77.14	22.85	21.6	30.00	10.0	58.33	41.66	31.6	3.85
2–3	34	28	59.17	3.5	64.28	85.29	14.70	42.8	41.70		50.00	50.00	42.8	3.59
3–5	33	29	54.57	6.8	66.50	87.87	12.12	28.2	39.39		48.27	51.72	37.8	4.36
Over 5	25	23	56.68	4.3	56.52	88.00	12.00	43.4	44.00	8.6	43.47	56.52	47.8	4.20

had not ceased to menstruate reported irregularity of the periods, and 40 (12.01 per cent) menstruated profusely.

A patient giving a history of metrorrhagia or of an abnormal vaginal discharge should have a thorough examination to determine the cause of the symptoms before treatment is instituted. If palpation and visualization of the cervix do not show evidence of disease, and if the symptoms are rather indefinite, curettage for diagnosis should be done under anæsthesia. If microscopic examination of the tissue removed shows the presence of carcinoma, hysterectomy should follow under the same anæsthesia. Hysterectomy is better done without preliminary curettement and should be done in the face of negative curettage if the symptoms are definitely those of malignancy and the patient is a good surgical risk. Occasionally a small area of carcinoma in an early case is missed by the curette and a diagnosis of non-malignancy is made, to be corrected later by the clinical history of the patient.

Before menopause a submucous myoma may cause metrorrhagia and in most instances hysterectomy is indicated rather than the use of radium. In The Mayo Clinic we feel that radium has not given satisfactory results in the treatment of submucous myoma. After the menopause, pyometritis may produce a foul and bloody discharge, usually more purulent than bloody, and the uterus is more often tender on palpation than if carcinoma is present. Currettement in such cases is contra-indicated; hysterectomy is the treatment of choice unless there is definite contra-indication to operation. Occasionally a patient with hypertension will have metrorrhagia, but a diagnostic curettage should be done before the arteriosclerosis is assumed to be the cause of the metrorrhagia and the patient should be carefully watched; if the symptom does not disappear with lowering of the blood pressure operative procedures should be considered. A preliminary curettage was performed on 38 patients, and 13 (34.21 per cent) died of recurrence and metastasis; 11 died within 5 years after operation and 2 lived 5 and 6 years respectively. Twelve patients were given intra-uterine radium treatment previous to hysterectomy. Five of the patients were poor surgical risks because of obesity or a heart lesion, and radium was given while the patient was being prepared for operation. Five patients had been given radium elsewhere a few months previous to the examination and operation at the clinic. Two patients were given radium for uterine myoma, one 2 years previous to the operation and one received two treatments 7 years and 2½ years previously.

Three hundred and six histories, in which the time of onset of symptoms was definitely stated, were studied to determine the relationship of the duration of symptoms, the extension of the disease, the type of operation performed, and the postoperative duration of life. The result of this study is shown in Table I. It is interesting to note that 144 (47.05 per cent) of the 306 patients sought medical advice during the first year of symptoms, and it is also noted that a greater per-

TABLE II.—DURATION OF LIFE AFTER HYSTERECTOMY FOR CARCINOMA OF THE FUNDUS OF THE UTERUS, 1907 TO 1923, INCLUSIVE

Year	Patients	Deaths in hospital	Patients not traced	Duration of life, years													
				Less than 1 year	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 12	12 to 15	15 to 18	18 to 20
1907	8		3	1* 2	1												1**
1908	10		1	2					1							1	5**
1909	14		2	1* 2												1	4**
1910	22	2	1	1* 4	1	1*** 1		1			1*		1	2***	1***	4**	1**
1911	8	2				1		1				1			1	2**	
1912	11	1		3	1	1							1*	1***		3**	
1913	19	1		1*** 2	2	2	1					1*** 1	1***	1**	1*** 4**	1**	
1914	19	2	1	2	1	1*** 1	1				1**			1*	1*** 6**	1**	
1915	16	1	1	1	1	2	3					1				6**	
1916	22		2	1	4	2*** 1								1*	1*** 10**		
1917	26		2	1*** 1* 1	1*** 4		1			1	1***	1*		12**			
1918	24	1	4	1	2	1	2	2	1				7**	3**			
1919	31		3	2*		3		1	1*** 1	3**	1***	1 13**	2**				
1920	32	4	1	4	2	3			1**	1***	14**	2**					
1921	31	2	3	4	1	1	1			1 14**	4**						
1922	17	1	1			1		1***	9**	4**							
1923	23	1	2	3	2				15**								
Total	333	18	27	40	27	22	9	6	29	24	22	21	12	21	31	13	11
									25**	21**	19**	15**	9**	16**	26**	11**	11**

**Living at last report, 153 (53.1 per cent of 288).
***Died from causes other than malignancy, 21 (15.5 per cent) of the 135 dead.
*Cause of death unknown, 11 (8.14 per cent) of the 135 dead.

centage of these patients were less than 50 years of age than in the other groups, and that the growth was considered grossly extensive by the surgeon at operation in only 15.8 per cent of the cases in the group, while in those in which symptoms had existed for 1 or 2 years the growth was noted as extensive in 21.6 per cent. In those in which the symptoms had existed for from 3 to 5 years, it was extensive in 28.2 per cent. In those in which symptoms had existed for more than 5 years the growth was extensive in 43.3 per cent.

However, in the 126 patients traced, who had had symptoms for less than one year, 60.3 per cent lived more than 5 years and 39.6 per cent of the total number of this group had died of malignancy at the time of the last report. Of those who had had symptoms more than 5 years 56.52 per cent lived more than 5 years, 47.8 per cent of the entire group having died of malignancy at the time of the last report.

It is difficult to explain the statistics of the second group of cases, in which symptoms had existed for from 1 to 2 years, since 66 per cent of the 60 patients traced lived more than 5 years, and 41.66 per cent are dead, 31.6 per cent having died of malignancy at the time of the last report. The average postoperative life of those who died was 3.85 years. In the group of 28 patients traced of the 34 who had had symptoms from 2 to 3 years, a slightly

smaller percentage lived more than 5 years, and the average postoperative life of those who died was 3.59 years. In the group of 25 patients traced of the 33 who had symptoms from 3 to 5 years, 66.5 per cent lived more than 5 years, and 51.72 per cent had died at the time of the last report. Thirty-seven and eight tenths per cent died of malignancy and the average duration of postoperative life was 4.36 years, an increase over the postoperative life of those having had symptoms for a shorter time. In the group of 23 patients traced of the 25 who had had symptoms for more than 5 years, 56.52 per cent lived more than 5 years and 56.52 per cent were dead at the time of the last report; 47.8 per cent (more than in any other group of shorter duration of symptoms) died of malignancy and in this group the postoperative life was 4.2 years, longer than among those having had symptoms for less than 3 years.

An attempt has not been made in this study to determine the grades of malignancy, according to MacCarty and Broders. Mahle, in 1919, showed that there was a constant relationship between the grade of malignancy and the postoperative life, which probably would explain the short postoperative life of those patients who had had symptoms for the shortest length of time. The disease was considered grossly extensive by the surgeon at operation in 77 cases (23.12 per cent), the ovaries being involved in 26 cases and the tubes in 4.

It is impossible to determine the influence which the use of radium and roentgen-ray may have had on postoperative mortality and length of life, as it has not been used as a routine postoperative treatment but only in those cases in which the growth was found to be extensive at the time of operation. In 1 group only have the patients treated with radium and roentgen-ray outlived those not treated. These were the patients who had had symptoms for 2 and 3 years; 30.7 per cent died who had received radium treatment and 44.4 per cent of those not treated died.

The largest number of patients who died of recurrence died during the first 3 years after operation. A number of patients had recurrence after the fifth year, so it is suggested that the term "five-year arrested cases" be used rather than "five-year cures." In the group of 333 patients operated on there were 18 postoperative deaths, an operative mortality of 5.4 per cent. Two deaths were due to pulmonary embolism. Of the 333 patients 288 were traced. One hundred and eighty-four (63.88 per cent) lived more than 5 years. Of the 172 heard from who had been operated on 10 years or more previously, 76 (44.18 per cent) lived 10 years, and of the 79 heard from who had been operated on 15 years or more previously 23 (29.11 per cent) lived fifteen years. One hundred and fifty-three patients of the total 288 heard from (53.1 per cent) are still living, all more than 5 years after operation. Of the 103 who died of the original disease, 63 died of local recurrence and 32 died of abdominal and other metastasis; in 8 there was metastatic lymphatic involvement as well as local recurrence. Twenty-one died of causes other than malignancy and in eleven the cause of death is not known. Table II gives in detail the postoperative results in the entire group of 288 patients heard from.

The postoperative results in cases of carcinoma of the fundus of the uterus have always been considered more encouraging than those following operation for malignant growth in the other commonly affected organs. Rankin, in 1927, reported the results following operation in 305 cases of carcinoma of the rectum and rectosigmoid; 103 (35.7 per cent) of the patients lived 5 years after operation. Eusterman found that of 222 patients heard from following operation for carcinoma of the stomach, 56 (25.22 per cent) lived 5 years. In 827 cases of carcinoma of the breast with lymphatic involvement in which operation was performed Harrington found that 25.75 per cent of patients lived 5 years, and of the 430 patients without lymphatic involvement 67.44 per cent lived 5 years. Thus in both groups five-year arrested cases were obtained in 40 per cent.

In view of the foregoing data the 63.88 per cent of five-year arrested cases bears out the frequently made statement that better results are obtained following operation for carcinoma of the fundus of the uterus than following operation on carcinoma of other commonly affected organs. This is probably due

to the protection afforded by the uterine muscle, which renders the growth less accessible to the lymphatics and explains the fact that 70 per cent of the patients who died of malignancy had local recurrence rather than metastatic malignancy.

Radium and roentgen-rays have been used at The Mayo Clinic for only a small number of patients who were poor surgical risks and the results have been poor. If radium is used in amounts sufficient to destroy the carcinoma, ulceration of the healthy endometrium occurs and the mucosa of the bladder may be affected also.

CONCLUSIONS

1. Although carcinoma of the fundus occurs most commonly after the menopause it is fairly common in women less than 45 years of age, having occurred in 10.51 per cent of the cases in the series reported.

2. Metrorrhagia was the most common symptom and was the first symptom noted by 63.66 per cent of the patients in this series.

3. Uterine myoma occurs more than three times as often in women with carcinoma of the fundus of the uterus as in women without carcinoma of the fundus of the uterus. The symptoms may be attributed to the myoma and may cause a delay in the making of a diagnosis of malignancy.

4. Every patient having metrorrhagia or an abnormal vaginal discharge should be examined thoroughly to determine the cause of symptoms irrespective of age, and if the symptoms warrant it and the patient is not a poor surgical risk, hysterectomy should be done even if malignancy is not found by curettement.

5. The greatest number of the patients who died following operation for carcinoma of the fundus died during the first 3 years of local recurrence.

6. More five-year arrested cases result from operation for carcinoma of the fundus of the uterus than from operation for carcinoma in other commonly affected organs.

THE INFLUENCE OF TREATMENT WITH HYPERTONIC SODIUM CHLORIDE SOLUTIONS IN PATIENTS WITH ACUTE ABDOMINAL LESIONS

R. S. ANDERSON, M.D., AND REED ROCKWOOD, M.D., BALTIMORE, MARYLAND
Departments of Medicine and Surgery, University of Maryland

IN a recent paper we have reported a series of 52 cases suffering largely from acute abdominal conditions in which the chloride in the blood was low. We compared a series of untreated or inadequately treated cases with a series in which an attempt was made by treatment with intravenous injections of hypertonic sodium chloride to restore the blood chlorides to normal. The untreated series was divided into two groups: those with the chlorides above 260 milligrams[1] and those with the chlorides below 260 milligrams. In the latter group of patients who were untreated by hypertonic salt solution the mortality was three times that of the group with the blood chlorides above 260 milligrams. Apparently the patients with the milder degree of toxæmia were able to control it spontaneously without any other therapeutic assistance. We also reported a number of cases with chlorides below 260 milligrams treated with intravenous injections of hypertonic sodium chloride and glucose with very favorable results and discussed the rationale of this form of therapy. At this time we did not have enough patients to compare statistically the mortality of the treated and the untreated cases. Now we wish to publish a larger series with low blood chlorides which will give us ample material to compare statistically the reduction in mortality under treatment. From the list of treated cases in the preceding paper we have taken 8 in which abdominal lesions were present together with a chloride of less than 260 milligrams and in which the patients received adequate treatment by the methods previously described. To these we have added 22 further cases with chlorides below 260 milligrams which were properly treated. During the period of this study, the operating surgical personnel of the hospital and the surgical resident were unchanged, and the only alteration made in the treatment of this group of patients was the introduction of the frequent intravenous use of hypertonic solutions of sodium chloride and glucose.

The results of this form of therapy are shown in Table I. When all the cases in the series are considered, it is apparent that in the untreated cases the mortality rose from 25 to 50 per cent as the chloride content of the blood fell below 260 milligrams; while the mortality in the treated cases in which the chloride content was below 260 milligrams was reduced from 50 to 30 per cent as compared with the untreated cases. We did not feel that this statement of the situation told the whole story, however, since a number of patients died of such conditions as bronchopneumonia or cardiac failure. Although these were undoubtedly precipitated by the low general resistance of the patient, they were not directly concerned with the abdominal lesion. In addition, a number of general medical cases, such as encephalitis, bichloride poisoning, and so on, were included both in the patients living and the patients dead.

This leaves us a group of 77 patients, and this corrected mortality (Table I) shows still more strikingly the improvement brought about by the use of hypertonic sodium chloride solution. In the untreated cases with chlorides above 260 milligrams, there is only a 10 per cent mortality which rises fivefold to 52 per cent as the chloride content of the blood falls below 260 milligrams. But proper treatment of this toxic group of patients reduced the mortality from 52 per cent to 22 per cent, or more than half. In other words, out of every 100 deaths under the old methods of treatment about 60 cannot be prevented.

[1] Chlorides done on filtrate of whole blood by Whitehorn method and calculated as chloride (normal limits, between 400 and 500 milligrams).

TABLE I.—MORTALITY IN CONDITIONS WITH LOW BLOOD CHLORIDES

	Total cases	Deaths	Mortality per cent
Untreated above 260 mgm.			
Uncorrected	28	7	25
Corrected	21	2	10
Untreated below 260 mgm.			
Uncorrected	32	16	50
Corrected	23	12	52
Treated below 260 mgm.			
Uncorrected	30	9	30
Corrected	27	6	22

Total cases uncorrected: 90.
Total cases corrected: 71.

We have been a little uncertain just what procedure to advise in treating patients who are usually considered as surgical emergencies; that is, whether it is best to operate immediately and treat the toxæmia afterward, or whether it is preferable to defer operation for a few hours and thus attempt, at least, in part to control the symptoms. We are gradually accumulating material on this point, but we do not feel that as yet we have sufficient data for a final decision. In the case of patients with ruptured appendix and general peritonitis, we have noted a tendency among the surgeons in charge to delay operation for a few hours for medical management, if a definite diagnosis of rupture has been made. Our experience with cases of acute intestinal obstruction is that the mortality of these cases is arranged according to the number of hours of pre-operative medical treatment. The greatest percentage of recoveries occurs in the patients who are not operated upon immediately, but who are given a few hours of preparation.

As a rule, the fall in chlorides roughly parallels the severity of the toxæmia. This is not always the case, and the patient may occasionally show little toxæmia clinically with a low chloride. One of the cases reported is a marked example of this. After operation for the relief of intestinal obstruction, the patient continued to show a marked alkalosis, although her clinical condition was extremely satisfactory and she was therefore given no further intravenous treatment. We have noted a tendency in this group toward a very rapid clinical change for the worse and if treatment is not instituted, observation of the condition of the patient should be very close and frequent. Of course, such an attitude will result in the giving of intravenous medication occasionally to those who might not be in need of it, but it should in general tend to lower the mortality.

TABLE II.—COMPARISON OF CARBON DIOXIDE CAPACITY AND CHLORIDE IN BLOOD

The areas enclosed within the rules represent the normal values. The numbers represent the number of cases falling into the range of each square. This table shows that as the chloride falls there may be no change in acid base equilibrium, an acidosis or an alkalosis. There are nearly as many cases of mild acidosis as there are of alkalosis.

Blood chloride mgm.	CO_2 CAPACITY (vol. %) 10–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	91–100	Total number of cases
310–301	..	..	..	..	..	3	1	..	..	4
300–291	..	..	..	..	2	3	..	..	..	5
290–281	..	..	..	..	2	1	..	..	..	3
280–271	..	..	2	1	2	4	2	..	1	12
270–261	..	..	..	..	6	5	5	2	..	18
260–251	..	..	..	3	3	10	..	1	..	17
250–241	..	..	1	3	..	3	5	..	2	14
240–231	..	..	..	1	3	3	2	3	1	13
230–221	..	..	..	2	3	3	..	..	..	8
220–211	..	..	..	..	..	3	..	..	..	3
210–200	..	..	..	..	1	..	..	1	1	3
Total...	..	..	3	10	22	38	15	7	5	100

We find since our first paper that we are abandoning almost entirely the 1 and 2 per cent sodium chloride solutions and are practically always using solutions of 5 and 10 per cent sodium chloride in 10 per cent glucose. In all of our series of intravenous injections, we have had only one reaction and this was not severe. Our only precautions are to insist that the water used in making solutions must be freshly distilled and that no solution should be kept longer than 3 days. We do not insist on triply distilled water as do some surgeons.

We have now accumulated sufficient chemical data to have some idea as to the interrelationships between the non-protein nitrogen, chloride, and carbon dioxide capacity in this type of case. This material is partially presented in Table II. We have studied the relationship between the blood chlorides and the non-protein nitrogen in 165 cases and have found that as the chlorides fall the non-protein nitrogen may remain normal or be elevated. Thus the chloride is a more delicate indicator of the presence of the toxæmia than the non-protein nitrogen which represents more nearly an end stage.

A study of Table II shows the relation existing between the blood chlorides and the carbon dioxide capacity in 100 cases. It will be seen that as the chloride falls the acid-base equilibrium may be undisturbed or that either an alkalosis or an acidosis may exist. In fact, almost as many cases show a moderate acidosis as show an alkalosis. This is somewhat contrary to the impression gained by reading the literature that has appeared on the subject, which emphasizes the factor of alkalosis.

We have also noted that practically all the cases of alkalosis occur with non-protein nitrogen that is normal or nearly normal and that nearly all the cases of acidosis occur as the non-protein nitrogen rises.

An analysis of the literature on the chemical aspects of this question suggests the following explanation of these events. Many other factors than those discussed are certainly operative, however. The primary fate of the blood chloride is unknown. Vomiting due to the loss of hydrochloric acid certainly accentuates its fall. It has been claimed that even if vomiting does not occur, there is sufficient gastric dilatation with residual gastric contents to account for the chloride loss. In one of the cases of our series, there was a low chloride content with alkalosis without vomiting in which aspiration shortly after the blood test showed no residuum. We have seen a similar condition in a uræmic patient with extremely low chlorides in the blood. Whatever may be the cause, the disappearance of chloride leads to an excess of free base in the blood. This is apparently compensated for by a retention of carbon dioxide as carbonate. Thus, instead of sodium and potassium chloride in the blood, we have a substitution of sodium and potassium carbonate. This again is not the only factor causing a rise in carbon dioxide capacity, since analysis of the blood shows that there is not a milliquivalent replacement of the chloride ion by carbonate ion. In uræmia with nitrogen retention there is a tendency to acidosis, due mainly to a retention of acid radicles such as sulphate and phosphate by the kidney. Apparently, similar factors are present here, since as the non-protein nitrogen in the blood rises the carbon dioxide capacity falls from the level of alkalosis to normal or even below normal with the production of acidosis. It would seem, then, that the fall in chloride is the primary feature and this in some manner tends to cause a rise in carbonate and a rise in non-protein nitrogen, but as the non-protein nitrogen rises, conditions are changed so that there is a tendency to lower the bicarbonate of the blood. The actual amount of bicarbonate present at any given moment, therefore, will be the resultant of these two opposing groups of factors.

Much chemical work of this type was essential in working out this series of cases. It remains to be seen if this cannot be considerably simplified, so that the principles described above can be more easily applied in the treatment of patients in institutions where so much laboratory work is not easily available. As we have shown, the chloride is the most delicate of the 3 tests, and for this reason alone should be given preference to the others. So far as the treatment of the patient is concerned, the determination of the non-protein nitrogen is of little importance, since it is only an indication for forcing fluids and giving an adequate amount of glucose, steps which should have been taken in any event. Hence, this test can be omitted with little loss. The treatment with chloride alone is sufficient to relieve an alkalosis in most cases. If an acidosis is present, it is nearly always mild and disappears when the non-protein nitrogen returns to normal under treatment. Hence, the determination of the chloride alone will be sufficiently accurate for outlining treatment. The method of Whitehorn is simple and can be done in any laboratory which is equipped to do blood sugar tests. In fact, it is done with the same Folin-wu protein free filtrate. The volumetric standards can be purchased by the small hospital laboratory, instead of being made there, if necessary. In the case of patients not in the hospital, or where no facilities are available for blood chemistry, even the chloride determination can be dispensed with. Our series of cases clearly shows that patients with abdominal lesions showing the clinical signs of toxæmia de-

scribed in our preceding paper almost invariably show a low chloride content in the blood. In case of doubt, then, it is perfectly safe to give such intravenous injections when the toxæmia is clinically present. It will do no harm and may place the patient on the road to recovery. Since, from the emergency standpoint, the administration of salt is more important than the administration of glucose, in an urgent case the physician could boil up from 5 to 10 tablespoonfuls of table salt in a quart of distilled water, or even tap water, on the kitchen stove, give it intravenously, and be almost as scientific as his more favored professional brother with adequate hospital facilities.

We wish to emphasize again that all of these cases have been accumulated in less than 18 months in a hospital of less than 300 beds. We feel, therefore, that this syndrome is much more common than is generally supposed and is being overlooked in many places. Since proper therapy in this group of patients results in such a marked reduction in surgical mortality, it is advisable for every physician to be on the lookout for the manifestations of this syndrome in his own patients.

SUMMARY

1. A series of 90 patients with low blood chlorides, associated in most cases with acute abdominal lesions, is reported. The treatment of these patients with hypertonic salt solution intravenously has reduced the operative mortality more than one-half.

2. In acute cases, such as ruptured appendix with general peritonitis and acute intestinal obstruction, there is accumulating evidence to show that the mortality is reduced by giving the patient a course of pre-operative medical treatment, rather than operating immediately.

3. The fall in blood chloride usually parallels the severity of the toxæmia, but this is not always the case, since some patients may have a considerable fall without much clinical evidence of toxæmia.

4. A comparison of the chemical tests in this group for chloride, non-protein nitrogen, and carbon dioxide capacity has been made. The chloride is the most delicate indication of the toxæmia and may or may not be accompanied by a rise in non-protein nitrogen. The carbon dioxide capacity tends to rise until the rise in non-protein nitrogen occurs, when it begins to fall, often resulting in an acidosis rather than an alkalosis.

5. For practical therapeutic purposes, the laboratory work can be abridged so that only the blood chloride estimation is used, or intravenous medication may safely be given in the presence of clinical signs of the toxæmia without resort to the laboratory at all.

6. This large series of cases was collected from a small hospital in a short period of time; hence, we feel that this syndrome is being generally overlooked.

SUMMARY OF LIVING TREATED CASES WITH BLOOD CHLORIDE BELOW TWO HUNDRED SIXTY MILLIGRAMS

CASE 1. Male, white, aged 45 years, admitted to hospital September 19, 1927. Diagnosis: perforated duodenal ulcer with general peritonitis, of 24 hours' duration. Immediate operation, consisting of closure of perforation and drainage, was done. Postoperative treatment: lavage, enemas, and intravenous injections of 500 cubic centimeters of 10 per cent sodium chloride and 10 per cent glucose were given daily for 3 days.

BLOOD CHEMISTRY

	Cl. mgm.	CO^2 vols. %	N.P.N. mgm.
9–19	270	56	29
9–20	260	56	35
9–21	300	..	35

CASE 2. Male, colored, aged 26 years, was admitted to the hospital September 17, 1927. Diagnosis: perforated duodenal ulcer with peritonitis, of 36 hours' duration. Pre-operative treatment: intravenous injection of 500 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose. Operation a few hours later: closure of perforation and drainage. Postoperative care: intravenous injection of 500 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose for 3 days.

BLOOD CHEMISTRY

	Cl. mgm.	CO^2 vols. %	N.P.N. mgm.
9–17	245	..	32
9–19	290	58	41
9–20	290	60	32
9–21	300	..	36
9–22	280	..	31
9–23	265	..	35

CASE 3. Female, white, aged 26 years, was admitted to the hospital May 6, 1927. Diagnosis: carcinoma of the ovary with general carcinomatosis.

Exploratory laparotomy was done and the abdomen closed without drainage. Following operation patient began to suffer with distention, nausea, and vomiting. Postoperative treatment consisted in lavage, enemas, and the intravenous injection of 450 cubic centimeters of 2 per cent sodium chloride and 10 per cent glucose, daily for 3 days.

BLOOD CHEMISTRY

	Cl. mgm.	CO^2 vols. %	N.P.N mgm.
5–9	250	80	56
5–13	260	68	41
5–17	270	73	36

CASE 4. Male, white, aged 62 years, was admitted to the hospital September 28, 1927. Diagnosis: duodenal ulcer. Operation: posterior gastro-enterostomy. Ten days after operation patient began to vomit large amounts of greenish material. Stomach lavage was begun and intravenous injections of 500 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose were given daily for 3 days. Second operation: release of adhesions which were causing obstruction of the distal loop. A Murphy button was inserted between distal and proximal loops. Injections of 500 cubic centimeters of solutions named were given daily for 4 days.

BLOOD CHEMISTRY

	Cl. mgm.	CO^2 vols. %	N.P.N. mgm.
10–12	240	..	35
10–13	240	69	42
10–14	265	..	38
10–15	300	..	24

CASE 5. Male, white, aged 32 years, was admitted to hospital June 30, 1927. Diagnosis: intestinal obstruction due to postoperative adhesions. Pre-operative care: lavage, enemas, and intravenous injections of 500 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose. Operation to relieve the obstructions was done a few hours later. Intravenous medication was continued daily for 4 days.

BLOOD CHEMISTRY

	Cl. mgm.	CO^2 vols. %	N.P.N. mgm.
7–1	255	70	39
7–2	290	..	..
7–3	290	..	..
7–4	280	..	..
7–5	325	..	34

CASE 6. Male, white, aged 58 years, was admitted to hospital October 28, 1927. Diagnosis: intestinal obstruction, postoperative adhesions. Pre-operative care consisted in lavage, enemas, and two injections intravenously of 500 cubic centimeters each of 10 per cent sodium chloride and 10 per cent glucose solutions. At operation the obstruction was released. The patient was given daily injections of 500 cubic centimeters of the solution named.

BLOOD CHEMISTRY

	Cl. mgm.	CO^2 vols. %	N.P.N. mgm.
10–28	210	88	67
11–10	280	68	21

CASE 7. Male, white, aged 8 years, was admitted to hospital June 21, 1927. Diagnosis: ruptured appendix with general peritonitis. He was operated upon at once. Twenty-four hours after operation the patient became distended, vomited large amounts, and was very toxic. Treatment consisted of lavage and enemas, and intravenous medication was started, 400 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose being given daily for 3 days.

BLOOD CHEMISTRY

	Cl. mgm.	CO^2 vols. %	N.P.N. mgm.
Day of vomiting	215	..	50
After treatment 300	300	..	24

CASE 8. Male, white, aged 61 years, was admitted to hospital October 20, 1927. Diagnosis: strangulated femoral hernia of 17 hours' duration. Pre-operative treatment consisted in lavage, enemas, and two intravenous injections of 500 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose solution. Operation: reduction of hernia. Patient developed an ileus after operation. He was given intravenous injections of the solutions named, 500 cubic centimeters twice a day for 3 days.

BLOOD CHEMISTRY

	Cl. mgm.	CO^2 vols. %	N.P.N. mgm.
10–20	250	..	60
10–21	270	64	49
10–22	240	58	41

The cases mentioned are selected from a large series and show the changes in the blood chemistry produced by toxæmias of intestinal origin and how such toxæmias can be controlled by intravenous medication of glucose and sodium chloride. The best results obtained in dealing with such cases depend largely upon (1) repeated stomach lavage, (2) enemas, (3) the patient being allowed nothing by mouth, and (4) the intravenous injection of sodium chloride and glucose, the strength of the solutions depending largely upon the severity of the toxæmia; for most cases 5 per cent sodium chloride and 10 per cent glucose in 500 cubic centimeter quantities, repeated as often as necessary.

SUMMARY OF THREE FATAL TREATED CASES WITH BLOOD CHLORIDE BELOW TWO HUNDRED SIXTY MILLIGRAMS

CASE 1. Male, white, aged 32 years, was admitted to the hospital April 15, 1927. Diagnosis: gunshot wound of abdomen with perforation of small intestine and bladder. Immediate operation was done, consisting in resection of portion of small intestine, closure of bladder, and abdominal drainage. Patient

developed an ileus and peritonitis, the abdomen became distended, and he vomited. Lavage and enemas were given and intravenous medication was started. Five hundred cubic centimeters of 10 per cent sodium chloride and 10 per cent glucose were given twice a day for 4 days. Patient died of peritonitis.

BLOOD CHEMISTRY

	Cl. mgm.	CO^2 vols. %	N.P.N. mgm.
4–18	225	70	43
3 to 8 days later	230	59	31

CASE 2. Male, white, aged 28 years, was admitted September 7, 1927. Diagnosis: ruptured appendix with general peritonitis. Immediate operation consisted in appendectomy and drainage. Injections of 500 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose were given intravenously daily for 3 days. Two days after operation patient showed signs of obstruction and an enterostomy was done. Intravenous medication was continued but the patient died 2 days later.

BLOOD CHEMISTRY

	Cl. mgm.	CO^2 vols.%	N.P.N. mgm.
9–7	225	56	37
9–9 (obstruction)	250	70	32
9–10 (day of death)	280	60	50

CASE 3. Female, white, aged 58 years, was admitted to hospital May 31, 1927. Diagnosis: intestinal obstruction due to a large gall stone. She was given the usual pre-operative treatment: lavage, enemas, and one injection of 5 per cent sodium chloride and 10 per cent glucose, 500 cubic centimeters. Operation: removal of gall stone from intestine. Intravenous medication was continued for 3 days—500 cubic centimeters of solutions named, twice daily. Patient developed a marked ileus and enterostomy was done under local anæsthesia. She died a few hours after operation.

BLOOD CHEMISTRY

	Cl. mgm.	CO^2 vols. %	N.P.N mgm.
5–31	280	..	52
Day of death	300	..	51

We have other cases that could be reported in this group which would show that at the time of death, the toxæmia was under control by intravenous medication of glucose and sodium chloride, as shown by the blood chemistry, and that death was produced by other contributory factors. The few cases reported are selected from a large series.

REFERENCE

ROCKWOOD, R., and ANDERSON, R. S. Changes in the chloride metabolism in abdominal lesions. Surg., Gynec. & Obst., 1928, xlvi, 352–360.

THE HEART IN SURGERY

An Analysis of the Results of Surgery on Cardiac Patients during the Past Ten Years at the Massachusetts General Hospital[1]

HOWARD B. SPRAGUE, M.D., Boston, Massachusetts

THERE is, no doubt, a persistent difference of opinion between the surgeon and the internist about the importance of the heart in surgery. The reason for this is, I believe, simple but in need of honest discussion. It rests upon the following facts. In the first place, cessation of the heart beat is the condition most easily discovered at the moment of death. It is assumed, therefore, that something is wrong with the heart whenever death occurs. Yet, in an experimental animal, the heart, after its beating has been inhibited by toxic substances introduced into the circulation, can be isolated and made to beat again for hours with a proper perfusate. Second, the surgeon is apt to emphasize heart weakness and failure as an explanation of operative mortality, when the real cause may be surgical shock, hæmorrhage, sepsis, pneumonia, peritonitis, or the result of anæsthesia. Lastly, the internist makes dogmatic statements about the condition of the heart and tends to forget that the mechanisms involved in the failure and death of certain types of diseased hearts in man—notably the heart in hypertension—are totally unknown.

The situation, therefore, is that the internist believes he can diagnose heart disease in life but can state only in a general way the patient's chances under operation, while the surgeon may deny his ability to discover heart disease while the patient is alive but often confidently makes such a diagnosis if the patient dies.

It is not my intention to discuss the whole subject of the heart in surgery, for I feel that it has been well done in recent years. The conclusions of those who have considered this question are mainly these:

1. The heart cannot be considered apart from the vasomotor system.

2. The ability of the patient to carry on his daily activities without symptoms usually tells more about his myocardial power than can be discovered on examination of his heart.

3. No type of heart disease is, *per se*, a contra-indication to necessary surgery.

4. Congestive heart failure greatly increases the danger of complications and the mortality from surgery.

5. Medical treatment of a failing heart before operation in some cases may convert a poor surgical risk into a relatively good one.

6. Obese and chronically septic cases are poor risks for surgery.

7. The behavior of the respiration, pulse, and blood pressure during and after operation is the best clinical guide to both internist and surgeon.

8. Other things being equal, the skill of the anæsthetist and the surgeon is often the determining factor in assessing to the cardiac the risk of surgical procedures.

I am presenting here an analysis of the fate of proved cardiacs who have undergone surgery in this hospital in the 10 years prior to January 1, 1928. The data were obtained from a study of the records of all patients who, during this period, were discharged from surgical services with a diagnosis of heart disease. For the figures of the past 4 years I have also studied the reports of deaths on surgical services reported at the staff meetings. A fair number have probably eluded the search for various reasons, such as the fact that milder grades of heart disease are recognized more readily on medical than on surgical services. However, most of those with frank heart disease are undoubtedly included.

Of 284 such cardiac patients, 170 were selected for study. All but 21 of these patients were seen by medical consultants; 38 were seen by the cardiac service. Sixty-eight others were discharged without operation, because of a change in diagnosis, a mistaken admission to a surgical service, refusal of operation, and, rarely, because of the cardiac

[1]Read before the Clinical Congress of the American College of Surgeons, Massachusetts General Hospital, Boston, October 8, 1928.

status or other medical contra-indication. Forty-six were discarded because of insufficient evidence of heart disease, except such conditions as terminal pericarditis in septic cases or transient arrhythmias.

The postoperative course of these 170 cases (84 males and 86 females) has been reviewed to discover, if possible, what types of cardiac disease influence prognosis. They have been studied under etiological classifications and functional diagnoses in the cases of auricular fibrillation, heart block, and angina pectoris.

One hundred and ninety-two operations were performed on the total group of 170 patients. The anæsthetic was ether in 86 cases, local novocain in 44 cases, nitrous oxide and oxygen in 21, ethylene gas in 17, spinal novocain in 8, sacral novocain in 5, and different combinations in 11 cases. I can find no significant correlation between the type of anæsthesia and mortality in this series or between the mortality and the pre-operative blood pressure. It is worth noting that no patient died during or following operation from cerebral hæmorrhage although 19 had a systolic blood pressure of over 200 millimeters Hg.

In any consideration of death from heart disease, one must start with the statement that demonstrable heart failure takes only two main forms: congestive, with dyspnœa, orthopnœa, cyanosis, hepatic and pulmonary engorgement, and œdema; or anginal, with substernal oppression or other manifestation of angina pectoris, or by the allied conditions of pulmonary œdema or cardiac asthma. In general, a pronounced fall in blood pressure, pallor, cold sweat, and tachycardia (in the absence of coronary occlusion) is more apt to be a vasomotor disturbance or an evidence of shock or hæmorrhage. Rarely the onset of such arrhythmias as auricular fibrillation, auricular flutter, or paroxysmal tachycardia in an already weakened heart may give this picture. It is the picture of a heart with too little rather than too much blood to pump, but has often been incorrectly ascribed to "acute dilatation of the heart."

SUDDEN DEATH DURING OPERATION

Of the 170 patients in this series 42 died during or following operation (24 males and 18 females), a gross mortality of 24.7 per cent, but only 5 patients died suddenly on the operating table. One of these was a man of 52 operated on by mistake for perforated viscus in the throes of what must have been a coronary thrombosis; 1, a man of 37 with syphilitic aortitis and angina pectoris, undergoing a cervical sympathectomy; 1, an obese colored woman of 42 with a fibroid uterus of football size adherent to the sigmoid, cardiac enlargement, and acute myocardial degeneration and pulmonary œdema at autopsy; another was a negress of 23 with chronic rheumatic disease of mitral and aortic valves and adherent pericardium who died during the induction of ether anæsthesia before tonsillectomy was begun; and the last was a woman of 54 with hypertension and marked obstructive jaundice from carcinoma of the pancreas who died following a marked slowing of the heart rate during an ethylene anæsthesia for cholecystgastrostomy.

The relative infrequency of death from heart disease during operation is further emphasized by a survey of 20 other cases of unexpected death under anæsthesia occurring in this hospital in the past 5 years. In but one of these cases (a child of 5 years of age) was there known heart disease present. No adequate cause for death was found in 10 cases that came to autopsy. Six operations were tonsillectomies on 4 children under 5 years of age, 1 girl of 19, and 1 woman of 35. Fifteen patients were 40 years of age or younger and the oldest was a man of 60 undergoing resection of the second and third trigeminal nerve roots for carcinoma of the tonsillar fossa. Fourteen were having ether, and 1 each cocain plus novocain, novocain alone, nitrous oxide gas and oxygen, nitrous oxide gas, oxygen and anæsthol, spinal novocain and ethylene, and local novocain plus ethylene. Unexpected death on the operating table is, in our experience, more common in young people without heart disease than in old people with it.

CAUSE OF POSTOPERATIVE DEATHS

When we analyze further the deaths following operation we discover that of the 42 who died, only 22 (or a little less than 13 per cent of the total series) died from causes directly

referable to the heart. We must, of course, admit that cardiac disease may well have made some of the others more susceptible to pathological conditions from which they died, such as thrombosis, pulmonary embolism, and pneumonia. Of the cardiac deaths, 8 were congestive in type, 5 from possible or proved coronary occlusion, 3 anginal, 2 from the complication of a paroxysmal abnormal cardiac rhythm in weakened patients, and 1 each died from complete heart block, acute endocarditis, cryptic aortitis, and pulmonary œdema. Twenty died from extracardiac causes—6 from bronchopneumonia, 8 from sepsis, 2 from anæsthesia, 1 each from fractured skull, metastatic carcinoma and pelvic vein thrombosis, postoperative vomiting and hæmatemesis, and chronic tuberculous mediastino-pericarditis. Only 13 of the 42 who died were under 50 years of age and 8 were over 70. The duration of life after operation was from a few minutes to 62 days. Four died on the day of operation, 12 in the first 3 days, 20 in the first week. Seventeen lived more than one week and 9 more than 3 weeks. Not quite one-half of the cardiacs in our series who died lived more than a week after the operation.

RHEUMATIC HEART DISEASE

Forty-seven patients with rheumatic valvulitis and normal cardiac rhythm were operated on. Only 4 died: 1 following a laparotomy for gall-bladder disease which revealed only a congested liver, due, as autopsy showed, to acute endocarditis; 1 with bronchopneumonia and sepsis after curettage for incomplete abortion requiring three transfusions; 1 from general peritonitis following appendectomy for ruptured appendix; and 1 from anæsthesia prior to operation. Heart disease was probably not responsible for the death of any but the case of acute endocarditis. Congestive heart failure was, however, present in only 2 patients in this group before operation, neither of whom died. Members of this group survived appendectomy in 10 cases, laparotomy for other causes in 7, and thyroidectomy in 5.

Nine patients had auricular fibrillation as a result of rheumatic heart disease; of these 2 died. One was a woman of 45 who had a mid-thigh amputation because of embolic gangrene of her leg and died 50 days later of probable mesenteric thrombosis, and the other was a man of 48 who died 19 days after colostomy for carcinoma of the rectum with extensive metastases.

ARTERIOSCLEROTIC AND HYPERTENSIVE HEART DISEASE

It is in the group of degenerative heart disease, arteriosclerosis with or without hypertension, that the greatest mortality is found. This group is the one concerning the operability of which the internist and surgeon are most uncertain. Seventy-five such patients were included in this study and 24 died, one-half of them succumbing to heart failure. One of these was a man of 82 years, with aortic stenosis. However, another man of 52 years, who had had a coronary thrombosis, survived a two-stage operation for carcinoma of the rectum. Of the 24 with auricular fibrillation 9, or 37.5 per cent, died; of those surviving 2 had prostatectomy, 2 repair of hernia, and 1 each cholecystectomy, hysterectomy, colostomy, excision of thyroid adenoma, cervical repair, and embolectomy and amputation of a leg.

Six cases of relatively pure hypertensive heart disease were submitted to operation. They were all women. Cholecystostomy, cholecystectomy, cholecystgastrostomy, hysterectomy, nephrectomy, and dilatation of anal fissure were the operations. Ether was given in 5 cases, combined once each with anæsthol and with spinal novocain, and ethylene once. Three patients died, 1 from the anæsthetic, 1 from pulmonary œdema, and 1 with postoperative vomiting and hæmatemesis.

MISCELLANEOUS ETIOLOGICAL FACTORS

I have collected only a small group of thyroid heart disease. Of 14 such cardiacs with auricular fibrillation only 1 died, a woman of 62 with a thyroid adenoma, requiring hemithyroidectomy, who had also arteriosclerosis, hypertension, and congestive heart failure. Two patients with normal heart rhythm survived operation although 1, a girl of 12, died at home from exophthalmic goiter

3 months after ligation of the right thyroid artery.

Of 6 with syphilitic heart disease, exclusive of those with angina pectoris, 2 died: 1 suddenly with unsuspected aortitis during hysterectomy (the patient was not seen by the medical service) and the other with chronic sepsis and pneumonia following cholecystectomy for a necrotic gall bladder. The aortitis was not diagnosed in this case either, although the Wassermann was strongly positive. The other 4 cases had aortic regurgitation and all survived. One wonders if the presence of the diastolic murmur led to more care in anæsthesia. Ether was given to those who died, and local novocain, nitrous oxide gas and oxygen, spinal novocain plus ether, and ether alone to the others. The latter operations were, however, less severe: amputation of the penis, thyroidectomy, suprapubic prostatectomy, and ureterotomy. Of the 4 cases with syphilitic aortitis and angina pectoris, 2 died suddenly following cervical sympathectomy.

Two patients had Pick's syndrome with chronic ascites; one had a Talma operation and the other thoracotomy for empyema. Both died.

One baby with congenital heart disease was successfully operated on for hare lip. A boy of 16 with congenital pulmonic stenosis, cyanosis, and clubbed fingers had an uneventful recovery from an appendectomy for chronic appendicitis.

Angina pectoris. Thirteen cases of angina pectoris underwent surgery, 7 of them for cervical sympathectomy. Of the 7, 3 died following operation—1 on the table, one 3 hours after operation, and 1 on the day after his third operation. The only other death in the group with angina was the case of coronary thrombosis unfortunately submitted to laparotomy. Three other laparotomies and one thoracotomy were uneventfully survived.

Paroxysmal abnormal heart rhythms. Two cases of paroxysmal ectopic heart rhythm are worth special mention. Both patients died and their fate seemed definitely related to the onset of abnormal cardiac rhythms which are usually benign—paroxysmal auricular fibrillation and paroxysmal tachycardia.

An extremely obese woman of 46, with a preoperative blood pressure of 95 systolic and 60 diastolic, was operated on for fibroids. A myomectomy for pedunculated fibroid was being done, but after 50 minutes of ether anæsthesia the heart suddenly developed auricular fibrillation said to have been first at a ventricular rate of 250 and later at 150. The blood pressure remained very low and she died 6 hours later. More apprehension was felt by the surgeons during this attack, and rightly (as was justified by the subsequent fatality), than by the medical consultant. The surgical fear was based on the persistently low blood pressure and the medical optimism upon the fact that postoperative paroxysmal fibrillation is usually temporary and relatively benign. The autopsy report showed an unusually obese woman whose muscles were pale pink and very flabby. The mesentery was laden with a great amount of fat, and the large intestine was completely invested with a thick, fatty covering. The heart weighed 415 grams, an unusually heavy deposit of fat being present in the epicardium especially over the right ventricle. The heart was otherwise negative. The liver weighed 2,085 grams and was flabby and a pale yellow pasty brown. In the pancreas the lobules appeared as "whitish islands in a sea of fat." The heart was negative microscopically except for a few small areas of fibrosis.

It is possible that this case shows in a marked degree the elements which make obese patients poor surgical risks. The factors seem to be the weak musculature in general, the mechanical oppression of fatty masses, the replacement by fat of the tissues of vital organs, the respiratory and circulatory disturbances (in this case due to the Trendelenburg position), the supersaturation of the body by ether from its affinity for lipoids, and the possible endocrine dysfunction as evidenced by the obesity and hypotension. The onset of the abnormal cardiac rhythm, probably only functional in origin in this instance, further lowered the blood pressure and led, together with a state of shock, to death.

The second case was a man of 40 without a preoperative diagnosis of heart disease. His blood pressure was 140 systolic and 70 diastolic. Three days after a first-stage operation for carcinoma of the rectum, he suddenly developed a tachycardia of 180 lasting only a few hours. The resident on the cardiac service saw the patient and made a diagnosis of paroxysmal tachycardia and advised 3 grains of quinidine sulphate three times a day. No electrocardiogram was taken. The patient was progressing well until 4 days later when another attack started

at a rate of 220. He became restless and dyspnœic and 3 hours later died suddenly with marked shortness of breath. No autopsy was performed and because of the absence of graphic records one can only speculate on the mechanism of the attack. It may have been paroxysmal tachycardia of auricular or ventricular origin, or auricular flutter. The blood pressure during the attack was not recorded.

Both of these cases illustrate the possibility of confusion in prognosis which may arise when ectopic tachycardia suddenly appears in patients who are operated on. Generally such disorders are "functional" in nature, a term which signifies that we are unable to trace the cause to its origin in microscopic pathology. The heart is normal to our clinical and laboratory tests, except for an increased irritability. But just as paroxysmal tachycardia may be dangerous to patients with mitral stenosis, whose hearts are competent at slow rates, so may extremely rapid heart action be serious in rare cases in which there may be present some pathology which escapes our clinical diagnosis. Its effect may be through a decrease in coronary flow. Experiences such as these should warn the cardiologist against a routinely sanguine prognosis in postoperative paroxysmal tachycardias.

In closing I may say that the analysis of these figures of our experience emphasizes certain points.

1. Age is the most important factor in mortality. Two-thirds of the deaths occurred in patients over the age of 50. In the 14 dying under the age of 50, syphilitic heart disease was present in 3, rheumatic heart disease in 6 (2 with auricular fibrillation and 4 with normal rhythm), Pick's disease in 2, and hypertension, obesity plus hypotension, and unknown heart disease in 1 each. Such a preponderance of age in mortality is to be expected. Miller[1] recently found in a series of 1,000 surgical anæsthesias "in the cases where complicating organic disease was discovered at the preliminary examination, the mortality rate in patients over 50 was fourteen times as great as in the patients less than 50 years of age."

2. Patients with rheumatic heart disease and normal rhythm without congestive failure can be operated on with little danger.[2]

3. Cardiac patients, excepting those with syphilitic aortitis or advanced coronary disease, are not likely to die suddenly during operation. Patients without heart lesions, either by clinical or pathological standards, are more likely to die unexpectedly as a result of anæsthesia than are those with demonstrable heart disease. The cardiac succumbs generally to complications or heart failure during the postoperative period; almost one-half of our cases that died lived more than a week after the operation. Of the 42 deaths in our series of 170 cardiacs, only 22 died from heart disease.

4. The presence of auricular fibrillation increased the danger of death from operation in arteriosclerotic cases only from 34 to 37.5 per cent but in a small series of rheumatic heart cases from 8.8 to 22.2 per cent. Thyrocardiacs with auricular fibrillation do better with operation for the thyroid hyperfunction than any other group with this arrhythmia, due to the immediately favorable effect of thyroidectomy upon the heart.

5. Our records indicate an improvement over the past 10 years in cardiac diagnosis. They show, however, that better co-ordination of the medical and surgical viewpoints is possible if the suspected cardiac patient, especially the older one, is studied before operation, instead of when he is *in extremis* from which there may be no relief. Such co-operation will be instructive both to internist and surgeon.

6. In a discussion of this subject 27 years ago before the College of Physicians of Philadelphia, Dr. Ochsner[3] said: "I think it would be unfortunate should surgeons receive the impression that patients suffering from heart disease are especially safe. I believe they are safe because they are considered especially unsafe." From our experience I should be inclined to agree with this statement, and so long as surgeons consider cardiac patients "especially unsafe" I believe that their future in the hands of the surgeon is relatively bright.

[1] Miller, A. H. "The influence of age in surgical prognosis" Am. J. Surg., Suppl. 1919, xxxiii, 112.

[2] It might be mentioned that at the House of the Good Samaritan in Boston, tonsillectomy has been performed on 214 children with actual or potential rheumatic carditis without a single death as an early or remote result of the operation.

[3] Ochsner. Discussion of paper by J. M. T. Finney. Anesthetics in heart disease. Tr. Coll. Phys. Phila., 1901, xxiii, 131.

SURGICAL ANATOMY OF THE THYROID GLAND WITH SPECIAL REFERENCE TO THE RELATIONS OF THE RECURRENT LARYNGEAL NERVE[1]

C. HAYNES FOWLER, M.D., F.A.C.S., AND WILLIAM A. HANSON, M.D., MINNEAPOLIS, MINNESOTA
From the Department of Anatomy, University of Minnesota

THIS paper is based on a careful dissection of 200 thyroid glands of cadavers in the department of anatomy at the University of Minnesota. The work was undertaken in an endeavor to establish more accurately, if possible, our knowledge of the normal and abnormal position and relations of the recurrent laryngeal nerve, the better to enable us to avoid injury to that structure, most important in surgery of the thyroid gland.

For the elementary classical description of the thyroid gland, the reader is referred to the standard textbooks of anatomy. The authors will discuss at length only those features which have a distinctly surgical significance, or those which from this study seem to differ from the usual description of this organ.

GENERAL CONSIDERATIONS

The thyroid gland is a bilobed, very vascular organ which is situated in the neck over the front and sides of the upper part of the trachea, extending upward on each side of the larynx (Fig. 6). It consists of two ovoid lateral lobes, united near their lower borders by a median transverse portion, the isthmus. In this series of 200 cases, the average width of each lobe was 3.25 centimeters; the average length (vertical) was 4.92 centimeters; and the depth (anteroposterior diameter) 2.88 centimeters. The average lobe extended from the upper portion of the lamina of the thyroid cartilage to a distance of 2 centimeters above the clavicle. One hundred and sixty-four (82 per cent of 200 glands) were grossly normal; 36 (18 per cent) were pathological; and 22 (11 per cent) had pyramidal lobes. A gland was considered pathological, in an anatomical sense, when it contained distinct adenomatous masses, or when it was much larger than the average of the so-called normal glands. The presence of a pyramidal lobe was not considered pathological. The pyramidal lobes varied in size from a small nipple to a process 5 centimeters in length. There were five glands (2.5 per cent) which were found to extend retrotracheal.

The parathyroid glands were noted in each case and were uniformly found to be two small fleshy bodies, varying in size from a small pea to a gland 1 centimeter in diameter. They were found in close contact with the posterior surface of the middle third of each lobe. Often there was no visible fibrous tissue capsule between the parathyroid and thyroid glands.

The relation of the deep cervical fascia to the thyroid gland was of particular interest in this study because of the fact that the so-called capsule of the thyroid gland is made up of the middle or pretracheal layer of this fascia, and because of the usual statement in discussions on the surgery of the thyroid gland that if one remains within this capsule, many if not all of the dangers of thyroidectomy will be avoided. Many pages of every textbook of anatomy are devoted to a detailed and confusing description of the deep cervical fascia of the neck. It is ordinarily described as consisting of three layers: (1) a superficial, (2) a middle or pretracheal, and (3) a deep or prevertebral layer (Fig. 1A).

The first or superficial layer extends from the ligamentum nuchæ posteriorly, to the midline of the neck anteriorly, and encloses within it the trapezius and sternomastoid muscles. Superiorly this layer extends to the mandible where it is continuous with the deep fascia over the face. Inferiorly it is attached to the upper border of the clavicle and manubrium sterni. This layer is a fairly distinct anatomical entity and one easily demonstrated.

The second, middle, or pretracheal layer is described as enclosing the thyroid gland and blending posterolaterally with the medial surface of the carotid sheath. Superiorly this

[1]Read before the Minneapolis Surgical Society, October 4, 1928.

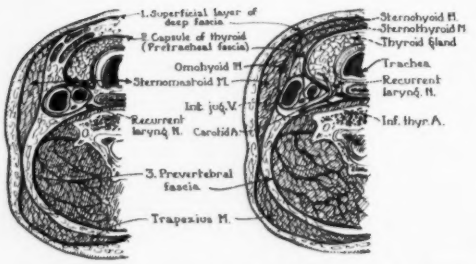

Fig. 1A (left). Cross section of neck at level of isthmus of thyroid gland. (From Cunningham's *Anatomy*.)

Fig. 1B. Cross section at same level as Figure 1A, showing relations of cervical fascia, recurrent nerve, and inferior thyroid artery as authors found them.

layer is attached to the cricoid cartilage and the lamina of the thyroid cartilage below the insertion of the sternothyroid muscle. Inferiorly it passes down posterior to the sternum into the middle mediastinum to fuse with the fibrous pericardium. This forms therefore the so-called capsule of the thyroid gland which is spoken of so glibly and is considered the wall of safety for surgeons, inside of which no harm can come and outside of which dangers await. In only a few instances in this dissection of 200 glands, were the authors able to demonstrate this fascial layer as being of sufficient strength and consistency to be separated in one distinct sheet from the thyroid gland on the inside, and the common carotid artery, the internal jugular vein, the inferior thyroid artery, and surrounding areolar tissue on the outside. We did find that this layer of fascia was uniformly well developed over the lateral surface of the thyroid cartilage, where it held the superior pole of the gland firmly in place (Fig. 2). We were also able to demonstrate that in nearly 100 per cent of the cases the major portion of what capsule or fascia was present, did not ensheath the thyroid gland on its posterior and medial surfaces. It was, on the contrary, reflected from the posterolateral border of the gland, posterior to the œsophagus, to fuse with its fellow of the opposite side (Fig. 1B). This is in accord with the description of this fascia given by F. de Quervain.

The third, posterior, or prevertebral layer of the deep cervical fascia encloses the muscles surrounding the vertebral column and assists in the formation of the posterior wall of the carotid sheath. This layer has no important relation to the thyroid gland and is mentioned only for completeness of description.

VASCULAR SYSTEM

The abundance of the blood supply of the thyroid gland is known to every anatomist and surgeon. The large superior thyroid arteries (Fig. 6) arise from the external carotid on a level with the thyroid notch and pass downward in an arch which is convex upward to the upper pole of each lobe. Here each artery divides into two or three main branches which spread out chiefly on the anterior and lateral surfaces of the gland to supply the upper half of the lobe and finally to anastomose with branches from the inferior thyroid artery. In rare instances the superior thyroid artery may arise from the common carotid. This did not occur in a single instance in this series of 400 arteries. An important anatomical fact to be remembered by the surgeon, especially in connection with ligation of the superior thyroid artery, is that this is the only artery in the neck in which the blood flow is toward the heart.

The inferior thyroid arteries (Fig. 6) are the chief blood supply to the lower and posterior portions of the thyroid gland. Each arises as one of the 3 terminal divisions of the thyroid axis (truncus thyreocervicalis), which in turn is a short stout trunk arising deep in the neck from the subclavian artery on each side. Each inferior thyroid artery passes at first almost vertically upward from 2 to 4 centimeters, lying very deep in the neck posterior to the common carotid artery, internal jugular vein, and vagus nerve. It then turns abruptly on itself to descend about half its length and pass medially to enter the posterolateral border of each lobe at the junction of its middle and lower thirds. Before it reaches the gland each artery divides into four to six smaller branches. It is just after this division and before these branches reach the gland proper that the recurrent laryngeal nerve comes into close relation with this artery. This important relation will be discussed later. In order to reach the gland proper, the branches of the inferior thyroid artery must necessarily perforate the

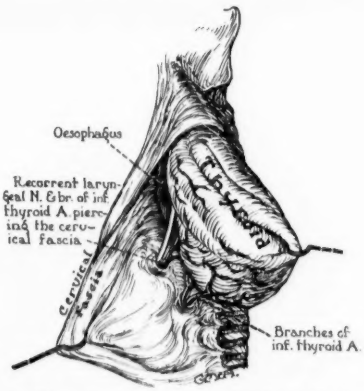
Oesophagus
Recurrent laryngeal N. & br. of inf. thyroid A. piercing the cervical fascia
Thyroid
Cervical fascia
Branches of inf. thyroid A.

Fig. 2. Dissection showing unusually well developed pretracheal layer of deep cervical fascia forming the capsule of the thyroid gland. Note dense investment about superior pole. Also reflection of fascia posterior to œsophagus instead of around the medial surface of thyroid gland.

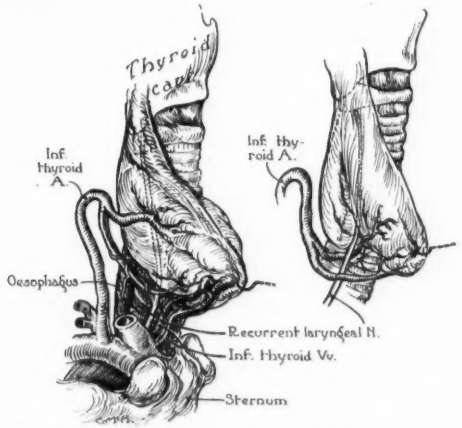

Fig. 3A (left). Dissection showing recurrent laryngeal nerve in more anterior plane than normal. Note intimate relation of nerve to inferior thyroid veins and artery.

Fig. 3B. Dissection showing recurrent laryngeal nerve in more anterior plane than normal, passing between the main branches of inferior thyroid artery as they enter the lower pole. Also note portion of right lobe extending posterior to nerve.

pretracheal layer of deep cervical fascia (so-called capsule), which they do in its posterior portion (Fig. 1B and Fig. 2). Occasionally this occurs more anteriorly as is shown in Figure 2. In addition to supplying the thyroid gland, each inferior thyroid artery gives small branches to the parathyroid glands, the œsophagus, the trachea, larynx, and muscles. In 4 cases of this series the inferior thyroid arteries were very large vessels, measuring in one case one half a centimeter in diameter. In another specimen the artery took a large "s" shaped curve.

An accessory artery, the thyroidea ima, was present in 4 cases of this series, in each case arising from the innominate artery and entering the isthmus of the gland. In one specimen the innominate artery rose unusually high in the neck and lay in direct contact with the lower pole of the right lobe.

The superior and middle thyroid veins emerge from the upper and lateral portions of each lobe, pass through what fibrous tissue capsule is present, and empty their blood into the internal jugular vein of each side. The inferior thyroid veins drain the lower portion of each lobe. They are large and tortuous. They may join together in one trunk or enter separately into the left innominate vein. The veins, as usual, we found to be far less constant than the arteries in size and position. From the surgical standpoint the veins in this region are much more troublesome than the arteries. The inferior thyroid veins often form a dense network of venous channels surrounding the lower poles and isthmus (Fig. 6). In many cases they were in direct contact with the recurrent laryngeal nerve (Fig. 3B). In one instance there was a large vein about 8 millimeters in diameter lying in direct contact with the lateral surface of the left lobe and extending the whole length of the gland to enter into the left innominate vein. In another case the internal jugular vein was located within the capsule of the thyroid gland. It is injury to these venous channels which is the cause of much of the serious hæmorrhage in thyroidectomy. The small spurting artery can easily be seen, caught, and ligated, but the constant and often profuse hæmorrhage from a large vein, the distal end of which has retracted into the cellular tissue laterally, is a condition which any surgeon would rather avoid. It therefore behooves us all to pay more attention to the normal and abnormal relations of these vessels and thereby avoid serious trouble.

The nerve supply of the thyroid gland proper is derived from the cervical sympathetic trunk. These nerves are of no particular

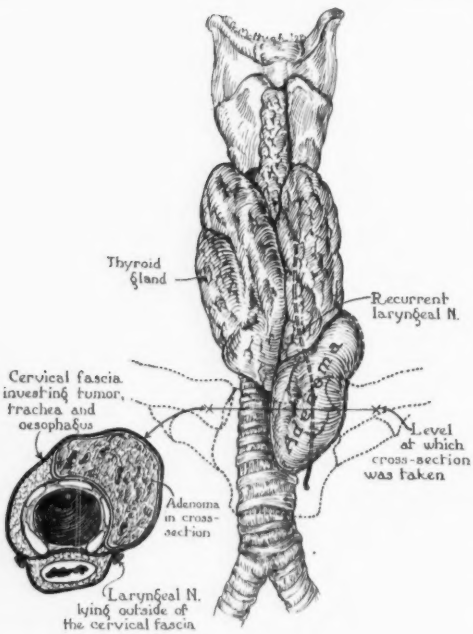
Thyroid gland
Recurrent laryngeal N.
Cervical fascia investing tumor, trachea and oesophagus
Level at which cross-section was taken
Adenoma in cross-section
Laryngeal N. lying outside of the cervical fascia

Fig. 4A (left). Dissection showing recurrent laryngeal nerve lying posterior to substernal adenoma. Nerve has just emerged from under arch of aorta. (Not shown in diagram).
Fig. 4B. Cross section of Figure 4A to show recurrent laryngeal nerve lying just posterior to adenoma, separated only by dense layer of deep cervical fascia.

interest in this discussion. The cutaneous nerves in this region are branches of the cervical plexus of spinal nerves and are well known and easily demonstrated.

The recurrent or inferior laryngeal nerve (Fig. 6) is a branch of the vagus and supplies all of the intrinsic muscles of the larynx except the cricothyroid muscle. The latter is supplied by the external laryngeal branch of the superior laryngeal nerve, also a branch of the vagus. Injury to the recurrent laryngeal nerve is not an uncommon occurrence during thyroidectomy. Statistics as to the frequency of such injury are difficult to obtain and vary from 1 per cent to as high as 14 per cent in some statistics several years old. The effect of trauma on the laryngeal nerves has been the subject of much experimentation and is still a moot question. Judd, New, and Mann in experiments on dogs found that section or ligation with linen, chromic or plain catgut produced a complete paralysis of the vocal cord of the corresponding side, which in all probability was permanent. They also found that pinching the nerve with a hæmostat, such as would occur by a surgeon picking up a small artery, produced a temporary paralysis of the vocal cord. Restoration of function occurred in these cases in from 30 to 60 days. Complete destruction of both nerves caused a total loss of voice, difficulty in swallowing, and dyspnœa either continuous or on exertion. These experiments on animals coincide to a large extent with the conditions found clinically in surgery of the thyroid gland.

This would seem to be sufficient reason for a more careful consideration and study of the relations of this most important structure in an endeavor to lessen the frequency of this dreaded complication of thyroidectomy.

As its name implies, the recurrent branch of the vagus arises after the parent trunk has left the neck. The long indirect course of the recurrent laryngeal nerve is brought about by the change of position which the heart and great vessels undergo during embryonic life. At first the mammalian heart lies under the middle of the head, immediately behind the first branchial arches. The fourth pair of branchial arches, by the modification of which the persistent aorta and innominate artery are formed, lies at first no farther back than the occipital region of the skull. The larynx is developed within this same region and the recurrent laryngeal branch of the vagus, with which it is supplied, passes at first directly to its destination, behind the fourth branchial arch. But as development proceeds, the heart and great vessels become detached from the branchial arches and move inferiorly until at length they are lodged deep in the thorax, while the larynx remains relatively stationary. Hence the recurrent laryngeal nerve becomes drawn out into a long loop, the middle of it pulled back, as it were, by the retrogression of the aortic arch into the thorax. The proof that the course of the recurrent nerves is a question of the development is found in the fact that when, from any cause operating in early life, irregularities of the arch of the aorta or in the origin of its primary branches exist,

the recurrent nerves have always, in such instances, an anomalous origin and course.

On the right side the recurrent nerve arises from the vagus just as the latter passes over the arch of the subclavian artery (Fig. 6). It hooks around the inferior and posterior surfaces of the subclavian artery and passes upward and medially in the soft tissues along the latter border of the trachea and œsophagus to reach the region of the thyroid gland. On the left side the nerve arises lower down in the thorax after the vagus has crossed the anterior surface of the arch of the aorta. The recurrent nerve then hooks around the aorta as its fellow of the opposite side does around the subclavian, and ascends into the neck on a deeper and more vertical plane than that of the right side. The usual textbook description and cross section of the position of the recurrent laryngeal nerve would lead us to believe that we would find it tucked snugly away in the crevice between the rounding surfaces of the trachea and œsophagus, well behind the capsule of the thyroid gland and therefore out of harm's way (Fig. 1A). The authors did not find this happy condition of affairs. In the region of the lower pole of the thyroid gland they found that the recurrent nerve lay from 1 to 2 centimeters lateral to the trachea (Fig. 6). Here it begins to entwine itself among the branches of the inferior thyroid artery. In 262 cases (65.5 per cent of 400) the nerve passed posterior to the main branches of the inferior thyroid artery; in 104 cases (26 per cent) it passed anterior; and in 34 cases (8.5 per cent) it passed between the main branches of the inferior thyroid artery. In this region, the nerve gives off minute branches to the œsophagus and trachea after which the main portion of the nerve, much reduced in size, continues on upward and more medially in very close relation to the posterior surface of the middle third of the thyroid gland. It then passes between the arch of the cricoid cartilage and the inferior cornu of the thyroid cartilage to enter the larynx and supply its intrinsic muscles. The authors were much impressed by the fact that in the large majority of cases, the most intimate relation between the gland and the nerve was not at the lower pole as is generally assumed, but rather

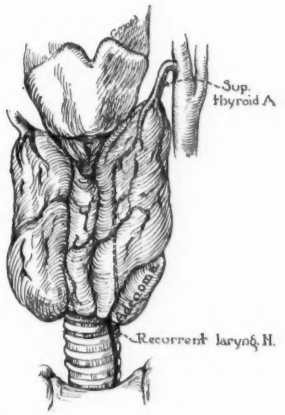

Fig. 5. Dissection showing left recurrent nerve passing between adenoma and left lobe of gland. Note liability of injury of nerve in enucleating such an adenoma.

on the posterolateral surface at the junction of the middle and lower thirds, namely at or just above the point where the chief branches of the inferior thyroid artery enter the gland. As noted previously the authors did not find the capsule of the thyroid gland to be such a consistently definite structure as it is usually considered, and when it was developed, it was found to be reflected from the posterolateral border of the gland to the posterior surface of the œsophagus (Fig. 1B). This being true, it is evident that in order to pass from its origin to its destination, the recurrent laryngeal nerve must perforate the capsule of the gland, if such be present (Fig. 1B and Fig. 2), and in any event come to lie in close apposition to the posterior surface of the thyroid gland inside of the capsule (Fig. 1B). The authors found this relation to exist in nearly 100 per cent of their cases, and therefore believe that the old teaching that the recurrent laryngeal nerve is always posterior to the capsule of the thyroid gland is an inaccurate observation and dangerous from the surgical standpoint because of the sense of security thereby imparted to inexperienced operators.

Many variations were found in the relation of this nerve, chief among which were the following: in 8 cases, the nerve was in a much more anterior plane, i.e., parallel with the anterior half of the trachea, and in two of

these specimens, it bridged over an extra large branch of the inferior thyroid artery in very close relation to the lower pole of the gland (Figs. 3A and B). In Case 41 (Figs. 4 A and B), the nerve lay directly between the substernal and regular lobe, separated only from the substernal portion by the dense layer of fascia which had been pushed down into the mediastinum ahead of the developing pathological lobe. In Case 47 (Fig. 5), the nerve was in direct contact with the posterior surface of a small adenoma. Case 53 (Fig. 2) showed clearly the branches of the nerve and artery perforating a well developed capsule. Case 70 (Fig. 3 B) showed an unusually large process of the gland extending posterolaterally from the middle third of the right lobe. In this case the nerve passed upward in the crevice between this process and the major portion of the lobe.

The authors also demonstrated that the position of the nerve with relation to the gland was not altered by any displacement or pulling anteriorly of the lobes of the thyroid gland. If such did not take place in fixed formalized specimens, it seems very unlikely that such a condition would obtain in the fresh living pliable tissues dealt with in surgery.

The authors have been unable to find any reference in the literature to injury of the external laryngeal nerve during thyroidectomy. It would seem from this study that such an accident might be very possible and may explain some cases of disturbance of the voice postoperatively. The external laryngeal nerve is one of the two divisions of the superior laryngeal nerve, a branch of the ganglion nodosum of the vagus high in the neck. This nerve (Fig. 6) passes obliquely downward and medialward, crossing posterior to both the internal and external carotid arteries to insinuate itself between the upper pole of the thyroid gland and the lamina of the thyroid cartilage. In this part of its course the nerve lies parallel with, and in very close relation to, the superior thyroid artery (Fig. 6). It continues obliquely across the thyroid cartilage to innervate the cricothyroid muscle. This muscle raises and retracts the cricoid cartilage and therefore tenses the vocal cords. The exact rôle which this tension plays in the physiology of a larynx is not definitely known. Hilton in his "Lectures on Rest and Pain," gives a theoretical explanation of this upward movement of the cricoid cartilage. In speaking of the motor branch of the superior laryngeal nerve, which supplies the cricothyroid muscle, he says: "No matter how rapidly the nervous influence passes, it must reach the nearest point first, and that is apparently the reason why this little nerve takes so short a course to the crico-thyreoideus. It has long been my habit to regard the crico-thyreoidei as the muscles which are intended to tune the vocal instrument; and, as the instrument must be tuned before it can be played upon, so this nervous influence, first reaching the cricothyreoidei, the vocal cords are put into a due state of tension, preparatory to the more precise and accurate influence of the other muscles acting directly and indirectly upon the vocal cords." New cut the superior laryngeal nerve in 4 dogs and observed no effect on the vocal cords. However, it seems to the authors that the human larynx being a much more highly developed and sensitized organ than that of dogs, injury to this nerve in man with the consequent paralysis of the cricothyroid muscle, may cause more interference with the function of the vocal cords than the same injury in dogs. At least, the function of this nerve is worthy of further investigation in order to determine whether or not we are overlooking a definite anatomical structure, injury to which may be causing some of our postoperative vocal disturbances.

SUMMARY

1. This paper is based on a dissection of 200 thyroid glands and 400 recurrent laryngeal nerves in cadavers in the department of anatomy, University of Minnesota.

2. A special emphasis has been placed upon the relation of the deep cervical fascia, inferior thyroid artery, and recurrent laryngeal nerves, from the standpoint of surgical anatomy.

3. The so-called "capsule" of the thyroid gland formed from the middle or pretracheal layer of deep cervical fascia was not found to be as definite an anatomical entity as is usually described.

4. The intimate relations between the inferior thyroid artery, veins, and the recurrent laryngeal nerve, were noted and discussed.

5. The reason for the indirect course of the recurrent laryngeal nerve is to be found in the embryology of this region.

6. The recurrent laryngeal nerve was found to lie inside of the capsule of the thyroid gland when such was well developed.

7. The closest relation between the nerve and the gland, and therefore the most dangerous area from a surgical standpoint, was found to be the posterior surface of the middle third of the lateral lobe of the thyroid, where the nerve was in direct contact with the gland.

8. In 262 cases (65.5 per cent of 400 nerves) the recurrent laryngeal nerve passed posterior to the main branches of the inferior thyroid artery; in 104 cases (26 per cent) it passed anterior; and in 34 cases (8.5 per cent) it passed between the main branches of the artery.

9. The position of the recurrent laryngeal nerve in relation to the vessels and adenomatous and substernal lobes varies greatly.

10. The authors were unable to demonstrate any change in the position of the nerve relative to the gland by anterior displacement of the lateral lobes.

11. The intimate relation between the external laryngeal branch of the superior laryngeal nerve and the superior thyroid artery and upper pole of the thyroid gland was noted, and its possible bearing on postoperative vocal disturbances discussed.

The authors wish to express their appreciation to Dr. C. M. Jackson, chief of the department of anatomy, University of Minnesota, for the opportunity to do this work and for his helpful suggestions in the preparation of this paper.

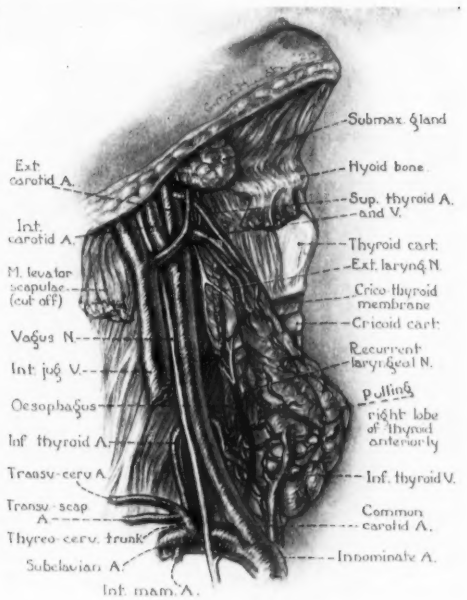

Fig. 6. Lateral view showing normal relations of thyroid gland to surrounding structures. Right lobe has been displaced anteriorly to display the posterior relations of the recurrent laryngeal nerve, the inferior thyroid artery and veins. The clavicle has been removed.

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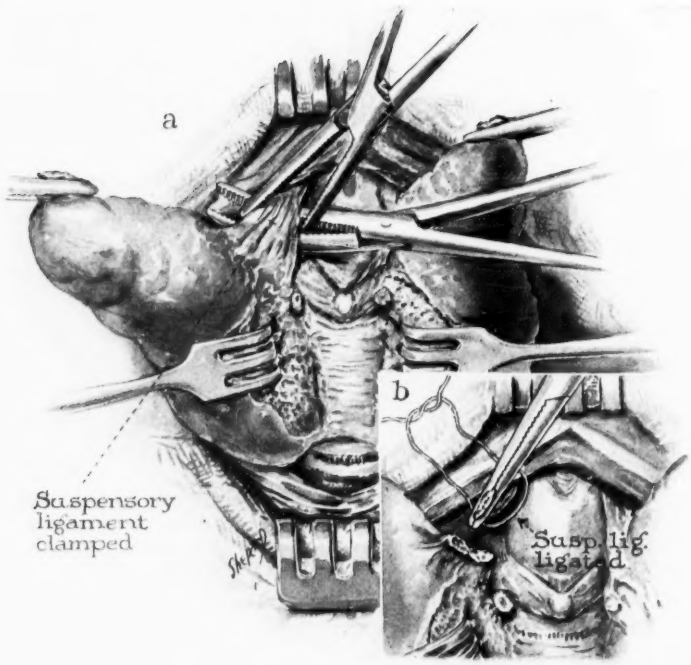

Fig. 4. Exposing the binding fascial structures at upper border of right half of isthmus and ligation of suspensory ligament.

Thyroidectomy.—H. M. Richter.

CLINICAL SURGERY

FROM NORTHWESTERN UNIVERSITY MEDICAL SCHOOL SURGICAL SERVICE

THYROIDECTOMY

H. M. RICHTER, M.D., F.A.C.S., CHICAGO

THYROIDECTOMY is indicated in any form of toxic goiter irrespective of any theoretical considerations of the cause or antecedent factors leading up to the thyrotoxicosis. The indications have been greatly broadened in recent years because of a better understanding of the relation of the thyroid to many diverse clinical manifestations, particularly cardiac disturbances. Long standing nodular goiters in the middle aged and aged, apparently harmless over a period of many years, have been found with increasing frequency to be the source of active, though often atypical, toxic symptoms. Mild toxic manifestations in the young, especially during periods of unusual stress and strain, as in young college girls and at puberty, while constituting very definite evidence of possible future danger, may yield to conservative measures. During pregnancy the basal metabolism is found quite consistently to rise above the average norm and not infrequently to be associated with moderate symptoms, often bizarre. Iodine will usually relieve the symptoms, or better still will prevent their development, when given prophylactically.

The indications for thyroidectomy for thyrotoxicosis are not limited by associated high grade cardiovascular damage or other complications. The existence of secondary damage may lengthen the period of preliminary preparation, though never for more than a few weeks. No degree of mental aberration is a contra-indication; my own cases include some who required physical restraint and were fed with the nasal or duodenal tube. Practically no complications render the condition inoperable.

GENERAL CONSIDERATIONS

A rather remarkable difference of opinion exists as to the desirability or danger of preliminary ligation of the four thyroid arteries. Some feel that bilateral ligation of the inferior thyroid arteries must endanger the integrity of the parathyroids; others find it entirely safe. Observation of the varying technique in use soon enables one to understand that it may be either safe or dangerous to ligate the inferior thyroids, depending entirely on the further steps of the method employed.

Surgeons who leave a considerable layer of thyroid tissue in front, and at the sides, of the trachea have no fear of bilateral ligation of the inferior thyroid arteries. The collateral circulation is ample for the security of the vascular supply. Thus continental surgeons, who in general have a far larger proportion of large non-toxic nodular goiters than we do, are more justified in using this method routinely. On the other hand, such a method must result in a very high percentage of recurrent thyrotoxicosis in the acute primary toxic types. Obviously, one may not ligate both inferior thyroid arteries and at the same time make a clean dissection of the thyroid from the trachea. Such a procedure would frequently result in the development of tetany.

The discussion of the relative value and danger of preliminary delivery of the thyroid is based much more on the method of exposure than on any inherent danger in the delivery of the gland *per se*. With a satisfactory skin incision and a free median splitting of the strap muscles, most glands of moderate size can readily be relieved completely of restraining filaments of tissue and can be delivered at will without force.

In large goiters, in goiters with unusually long superior poles, and particularly in the presence of substernal or thoracic extensions, free transverse division of the strap muscles is indicated. Their division between clamps was suggested many years ago by Charles Mayo, and this method is widely used. The clamps simplify greatly the control of the numerous ends and their resuture. They present, however, the very considerable disadvantage of failure to permit adequate retraction of the muscles, which after all, is the purpose of their division. Complete transverse

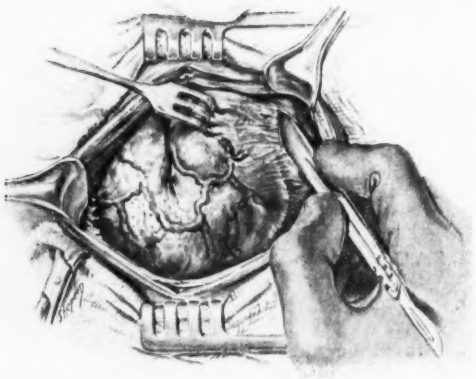

Fig. 1. Pressing back the web-like fibers of connective tissue at sides of gland.

division of these muscles, well out under the borders of the sternomastoid, without hindering clamps, flattens the neck, so as to convert the goiter from a buried tumor to a projecting mass. Delivery of the cervical tumor ceases then to be a problem.

The amount of thyroid tissue to be left behind is seldom correctly described; yet it is of vital importance in thyrotoxicosis. In non-toxic goiters any moderate amount of the gland may be left. If one side is not involved, it may remain intact. In large nodular goiters it may be difficult to find sufficient normal thyroid to leave. In thyrotoxicosis the problem is quite different.

Here a minimal amount of the thyroid only may be left, and in every case, without exception, the persistence of any degree of toxic symptoms is absolute proof that too much of the gland has been left behind. Perhaps the greatest single cause of error in this respect is the tendency to visualize the amount of thyroid to be removed in terms of a fraction of the size of the gland, as three-fourths, four-fifths, and so on. It is of basic importance to remember that not the fraction that we remove but the amount we leave behind determines the result. And the amount of thyroid tissue required to maintain function is remarkably small—probably only a few grams.

Another remarkable variation in the methods in use in different clinics is based on the need for so called "multiple operations." Under this head the operation is planned to be carried out in several sittings: most frequently a preliminary arterial or polar ligation is done; then partial or complete lobectomies to be followed by removal later of the remaining lobe. Before the introduction by Plummer of the use of iodine in the preparation of the patient for thyroidectomy, preliminary ligation of one or more vessels was carried out in an amazingly high percentage of patients in some clinics. Lobectomy as one stage of the complete operation is common practice today. The use of iodine has greatly reduced the number of two and more stage operations; but there seems to me to be little purpose in any such procedures. The postoperative reaction is due essentially to leaving enough thyroid to develop such a reaction. Moreover, a radical thyroidectomy requires but little more time and inflicts but little more injury upon the patient than an incomplete operation. It would seem logical to remove the thyroid radically, leaving a minimum of tissue to develop the postoperative reaction so greatly feared.

PRE-OPERATIVE CARE

Iodine in large doses as Lugol's solution is given for from 10 to 20 days. Actual improvement continues for a number of days after the patient's condition seems to have become satisfactory. It has seemed to me to be as effective in the nodular as in the primary hyperplastic type. In severe cases, as after a crisis, it is especially well to let the patient become stabilized. Food and liquids are pushed. There is no object in restricting the use of any type of food, as meats. Rest, not necessarily bed rest, is important. Body weight and metabolism should be watched.

TECHNIQUE

Anæsthesia. Thyroidectomy lends itself easily to block or local infiltration anæsthesia. In non-toxic or well controlled patients, who are not excitable, this method is very satisfactory. It is very desirable in the presence of any degree of respiratory difficulty from pressure. We have used it almost entirely combined with nitrous oxide-oxygen anæsthesia, borrowing much from Crile in so doing, but permitting the patient to become quite conscious during deep manipulations in the neighborhood of the recurrent laryngeal nerves. We proceed as follows:

The patient is placed comfortably on the table with the head extended, the upper half of the table being elevated, and the nitrous oxide anæsthesia is started. After iodine preparation of the skin, the patient is draped, and infiltration with one-fourth to one-half per cent novocain in normal salt solution is begun. The injection is entirely subcutaneous, from thyroid cartilage to clavicles and from one sternocleidomastoid to the

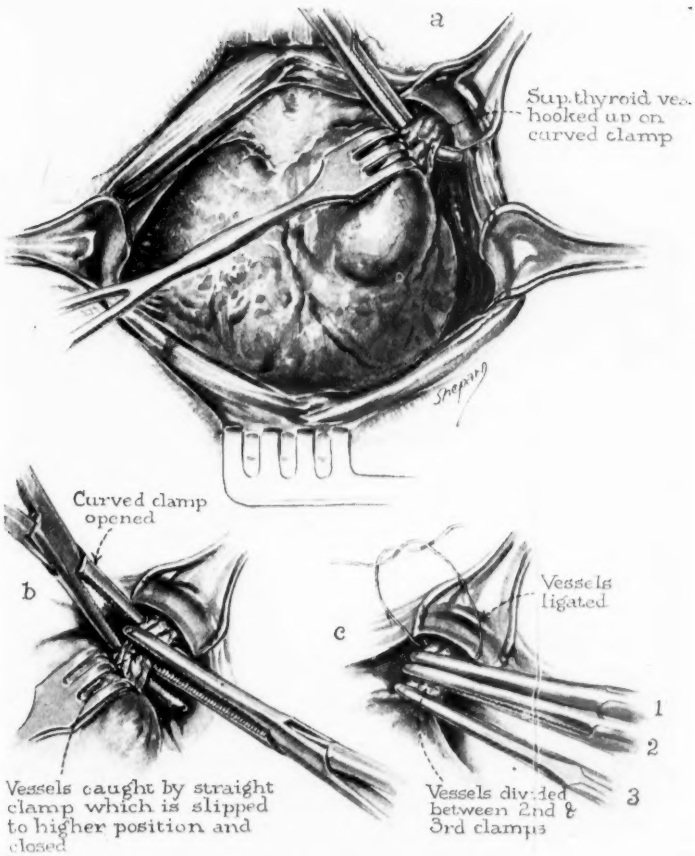

Fig. 2. Steps in ligating the blood vessels.

other. Besides the anæsthesia, the artificial œdema thus produced is a factor in simplifying the dissection of the flaps. We formerly employed the method of Kulenkampf but found the deep injections unnecessary. The block anæsthesia of Kappis is effective but also unnecessary. It may have a place in unusually large substernal goiters. I usually employ novocain solution without adrenalin, but occasionally find it necessary to reinject the skin margins before suturing. Adrenalin may be added with advantage in all but the more toxic cases in the proportion of one minim of the 1:1000 solution to the ounce of novocain solution, giving a strength of 1:500,000. I prefer one of the automatically refilling syringes which immediately warns of the puncture of a vein by drawing blood up into the barrel.

The operation is now continued under nitrous oxide anæsthesia until the area of the recurrent laryngeal nerves is reached, when the patient is allowed to awaken and is held in conversation during the dissection of this area. Should the patient be entirely confortable, the operation is continued and completed under the novocain anæsthesia. Any material discomfort of the patient, physical or psychic, is considered an indication immediately to add nitrous oxide. Since we have used this nitrous oxide-novocain combination and have kept the patient in conversation during the deep dissection, the incidence of nerve injuries has fallen very satisfactorily.

The incision. The approach is by way of a free transverse incision at such a level as to permit the scar to fall into the hollow area of the neck above

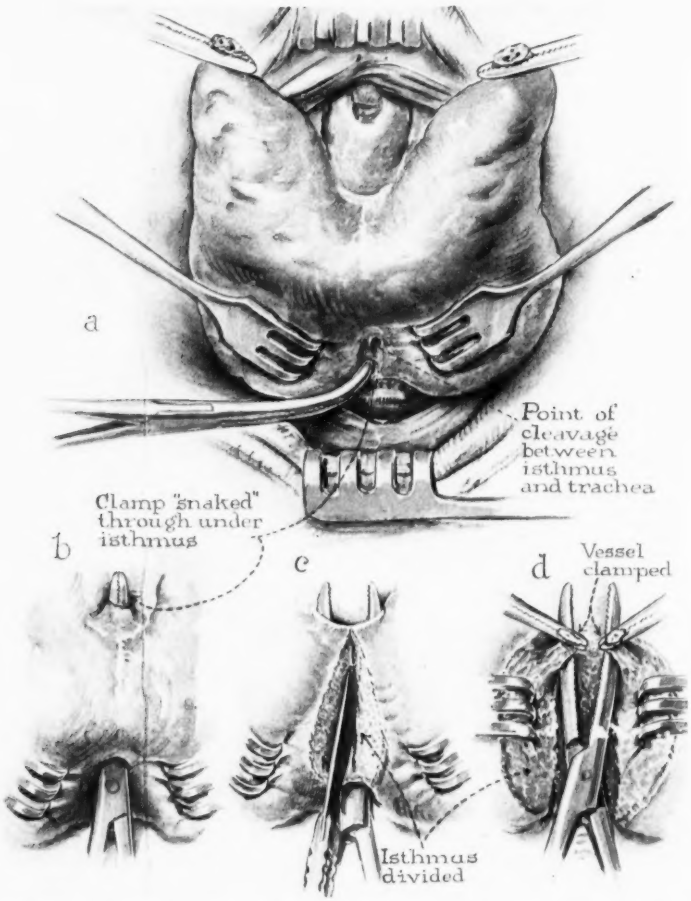

Fig. 3. Dividing the isthmus, the trachea is protected by forceps inserted between isthmus and trachea.

the sternal notch. This incision includes the platysma, which is quite intimately blended with the skin and for the most part is not apparent as a separate layer. Its length should be ample to give adequate access and obviously must vary with the requirements of the individual case. It should be perfectly transverse or bowed slightly downward. In very large, irregular nodular goiters the transverse incision should be relatively high, or the scar will fall below the intended line. Finally, in exceptionally large goiters, it may be desirable to give a strong downward curve to the incision. This gives a poor scar, but undoubtedly gives the best possible access, and may be used where a damaged heart and pressure dyspnœa add an unusual handicap.

Dissection of the upper flap is somewhat facilitated by the previous infiltration with novocain solution. It is freed well up to the notch of the thyroid cartilage. The lower flap requires less retraction or dissection but may be freed to the sternal notch in the midline. Where the anterior jugular or other large vein is accidentally injured, it is best to divide it between forceps and ligate. The flaps are held back by means of a self-retaining Beckman retractor.

Exposure. The pre-thyroid muscles are now separated by splitting in the midline, throughout their full length, from hyoid to sternum. The

most superficial or sternohyoid muscles are readily separated and retracted; the underlying sternothyroids are very thin and often not readily recognized as a covering of the gland, unless definitely sought. They are best picked up in the midline and peeled back with the handle of the scalpel. Their upper ends do not reach as high as the sternohyoids, and they may easily be torn off by the careless use of retractors.

When the strap muscles are retracted the structure of the thyroid will stand out very clearly, leaving no room even for the novice to be in doubt as to his position. At the sides of the gland, web-like fibers of connective tissue will be observed passing outward and backward. These bind and should be pressed back bluntly with the handle of the scalpel (Fig. 1), or a gauze sponge over the finger, etc. The important thing is that the gland should be dissected clean of all binding structures. Kocher recognized the importance of this technical step when he advised rather to cut into the gland than permit oneself to work outside the proper plane of cleavage (W. S. Halsted). If unusual exposure is required, the strap muscles may be divided transversely, as described above.

Delivery of the gland. The exposure of the side of the gland and the entire upper pole is greatly facilitated by the use of rake-shaped, sharp retractors that are actually hooked into the gland, instead of grasping the latter with forceps. For the idea of using retractors in this way I am indebted to Dr. Nelson Percy. An ordinary, sharp, three pronged retractor is used for this purpose. Hooking it into the outer side of the upper pole, usually the right pole first, we draw the latter gently downward and medianward, making all binding tissues apparent, when they are cut or pushed back as described. The pole is rolled progressively forward, the entering vessels coming prominently into view. Any difficulty in exposing the pole is usually due to failure to free it of normal binding structures, such as fibers of the lacerated sternothyroid muscle, or its adventitious capsule of loose connective tissue. Rarely an unusually long pole or one containing an adenoma may offer difficulties. Abnormal adhesions are never present, except in the form of scar tissue resulting from previous operations. Their apparent presence is always due to the failure of the surgeon to keep within the proper plane of cleavage.

With the right pole delivered and held by the hook retractor, a curved forceps is gently insinuated under the moderately tense superior thyroid vessels, passing from within outward, as they present themselves (Fig. 2a). The forceps

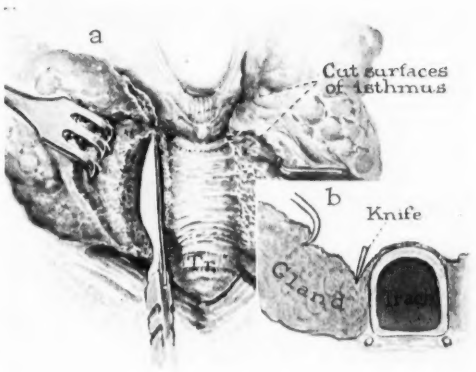

Fig. 5. The lobe is freed from the front of the trachea with sharp dissection. Insert shows knife shaving off thin layer to be left attached to posterior capsule.

may meet with some resistance but can be gently maneuvered under the vessels like a Kocher dissector, and then, the blades being separated, the vessels are readily grasped with forceps (Fig. 2b). To insure against accidental loss of the vessels they are grasped with two forceps and a third forceps placed close to the pole itself (Fig. 2c). The vessels are then divided and immediately ligated.

The left pole is now treated in a similar manner, and the vessels are divided and ligated. The outer sides of the lobes are further freed downward toward the lower pole, until the free delivery of the latter is accomplished, the same method of drawing the gland medianward with the pronged retractor while tensing and freeing the binding tissues from the outer and lower aspects of the lobe being used. This freeing process may be hampered by the lateral veins entering the outer border of the thyroid. If so, these are caught and divided between forceps and gland. While much mentioned, I have never found them a material source of trouble. Blindly forcing one's finger between gland and muscles may rupture the veins, but this should not happen if care is used. During the delivery of the lobe no serious attempt is made to divide the capsule or reach the vessels of the outer aspect of the gland. Complete freeing, except of the upper pole, is not contemplated. This can be done more readily at a later stage. No additional forceps, except those on the lateral veins, are applied to the lobe at the present time.

There is now a single forceps on the upper pole at the site of division and ligation of the vessels; at times, a second forceps on the lateral vein, on each side. Usually no other forceps are in position. The importance of forcing home this statement is

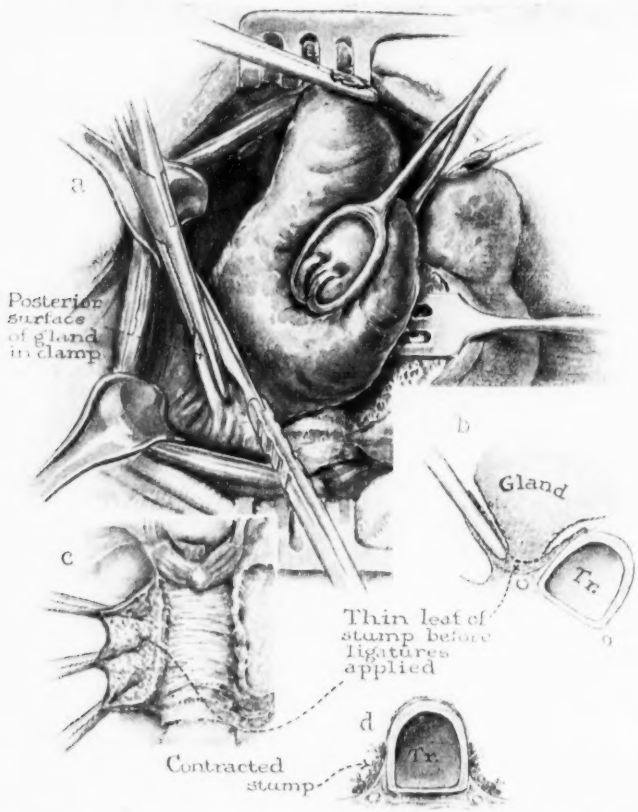

Fig. 6. The forceps are inserted into layer of tissue left, not behind it.

based on the fact that the necessity for placing many forceps while the gland is being raised and freed is caused either by the surgeon wandering out of his proper line of cleavage, in which case he may find himself in an interminable maze, or by his fearfully grasping innocent structures in no need of forceps. There are no vessels in the proper plane of cleavage here described, except as mentioned.

The superior poles are now free; the lateral aspects of the lobe and the lower pole partly free. The gland is still firmly held throughout by its posterior surface and the inferior thyroid arteries are intact. Above, the pyramidal process may extend well up to the hyoid bone. Extending upward from the isthmus is a rather firm binding tissue, an extension of the deep cervical fascia, binding the gland to the larynx. Below, a loose connective tissue extends from the lower border of the isthmus and inner aspects of the lower poles to the trachea, including superficially in its structure the median veins. The lower border of the isthmus is accurately located by the palpating finger, and a Kocher dissector or a curved forceps is insinuated between isthmus and trachea, gently forced upward to emerge beneath the upper border of the former (Fig. 3; a and b). The trachea being thus guarded, the isthmus is divided between forceps, or, better, simply cut through without forceps, bleeding being very satisfactorily controlled by making gentle traction with the hook retractors (Fig. 3; c and d). Usually not more than a vessel or two, often no vessel whatever, requires attention. The isthmus varies greatly in size and vascularity, but these bear no constant relation to each other.

The anterior surface of the trachea is now well exposed. Traction being made with the right

hook, the right lobe is gently everted and simultaneously the forceps originally placed on the right upper pole is raised. The effect is to make prominent the binding fascial structures at the upper border of the right half of the isthmus (Fig. 4). The curved forceps is insinuated beneath this structure, separating it from the trachea. The jaws being opened, the moderately tensed tissues are grasped with forceps and divided between it and the gland. Continuing the eversion of the right lobe, it is freed from the front of the trachea with sharp dissection, all loose connective and capsular tissue being left behind (Fig. 5). The knife edge then actually enters the thyroid (Fig. 5b), shaving off a thin layer that is left attached to the posterior capsule. An occasional vessel will be cut before being caught, the traction of the hook retractor lessening the bleeding. Very little blood is lost. Usually the fibrous septa carrying the vessels can be recognized and caught before they are cut. Remarkably few vessels require attention. The placing of innumerable forceps progressively in the thyroid substance before cutting is thus shown to be entirely needless. At the inner, lower border of the lower pole a forceps is pushed into the thyroid before it is cut. Frequently six to eight, usually not over ten, forceps suffice for each lobe including the outer capsule of a fair sized hyperplastic thyroid.

In the final severing of the posterior surface of the lobes it must be emphasized that a layer of but a few millimeters is left, and what forceps are used are inserted into this layer, not behind it (Fig. 6), thus following in principle the technique of Kocher, W. S. Halsted, and Charles Mayo, described years ago. During the dissection of the posterior surface of the gland, the patient is permitted to remain awake and is kept in conversation.

The gland now is free, except as it is held by the outer border of the capsule behind. This capsule is left to the last because the gland is now so well mobilized that, in applying forceps, a maximal amount of this tissue can be preserved with greater safety to the recurrent laryngeal nerve and better preservation of the parathyroids. The original Kocher goiter forceps make an excellent handle for manipulating the gland.

Right and left lobes are treated alike. The pyramidal process is usually removed with one of the lobes. When long, it may temporarily be divided and the upper end removed on completion of the operation. In large substernal or intrathoracic tumors, some difficulty may be experienced, the equator of the thoracic portion being actually larger at times than the introitus thoracis. The freeing of the upper poles, division of the suspensory ligament above the isthmus, and division of the isthmus must always precede any attempt at delivery. Great help is obtained by having the patient cough vigorously, traction being made from above simultaneously. Here again it is exceedingly important to sever all restraining bands, even the thinnest, as one proceeds. By bearing this simple procedure ever in mind, the impossible situation is completely changed, and what is at first an utterly immovable mass, rises progressively to the surface.

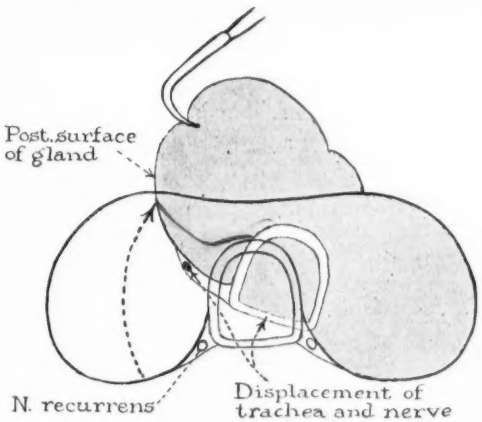

Fig. 7. Displacement of recurrent laryngeal nerve and parathyroid bodies by traction on gland. Hence, danger to them from careless application of forceps.

Closure. Before closure is begun the patient is asked to cough vigorously to start bleeding from vessels that may have escaped notice. Persistent oozing is treated by whipping over or through the thyroid stump—always with the patient conscious and talking. With the patient awake and quiet, injury to the recurrent laryngeal nerves may pass unnoticed. Nerve damage may be shown only on exertion or talking or coughing.

The neck is comfortably flexed, and the sternothyroid and sternohyoid muscles are accurately sutured if divided. No more difficulty is experienced in suturing the muscles than when muscle clamps are used. With the field perfectly dry, and air bubbles expressed to avoid dead spaces, the skin is now completely closed with a running subcuticular suture that I believe was suggested by W. S. Halsted in the early nineties. No drain is ever used as such. At times annoying oozing cannot readily be stopped. A small cigarette drain is then used to avoid a hæmatoma. Firm pressure, kept up by an assistant while the muscles are being sutured, helps prevent hæmatoma formation.

A snugly fitting, firm binder is applied over a large elastic mass of gauze to continue gentle pressure for several hours, after which it is removed, a simple dressing remaining.

The routine use of a drain of any kind seems quite unnecessary. If not used, a cleaner scar is left. A small serous effusion will occasionally develop but its evacuation with a sharp nosed forceps is a minor matter.

POSTOPERATIVE TREATMENT

The patient is returned to bed and placed in a semi-sitting position. A simple sedative, or morphine if required, is given as the occasion demands. Liquids are pushed. In the first 24 hours from 60 to 120 minims of Lugol's solution are administered. The amount is rapidly reduced to 10 minims daily, as the patient fails to show a postoperative reaction, and stopped when the patient leaves the hospital. Persistent nausea is probably of toxic origin and can be best combatted by means of large quantities of salt solution given subcutaneously, as suggested by Crile. Hypodermoclysis can be made relatively comfortable by Bartlett's method—adding 0.3 gram novocain (without adrenalin) to each liter of normal salt solution. Small needles are used and novocain is injected locally before the needles are inserted.

Food is added as the patient can take it.

SECONDARY OPERATIONS

Thyroidectomies following previous ligations or lobectomies present no special problems. It is frequently otherwise, however, in cases of previous inadequate attempts at thyroidectomy. Here the combination of distorted anatomical structures, binding scar tissue, irregularly distributed thyroid substance, and, in some cases, damaged nerves or parathyroids may add serious handicaps. Preoperative laryngoscopic studies, tests for latent parathyroid damage, and roentgenological studies of the chest for possible substernal masses are particularly important.

The first essential is to lay the field of operation widely open to inspection. The use of the scar of the earlier operation as the site of incision is usually preferable from the cosmetic standpoint. A very badly placed scar may have to be disregarded. The incision should be unusually free and the muscles well exposed. The latter should be separated in the median line and divided transversely if required, exposing thyroid or trachea as early in the operation as possible. Working outward from the median line, the thyroid should be progressively freed of adherent scar and muscle. No uniform method of approach is possible, but the various areas where thyroid is most likely to be left should be adequately investigated. Lateral masses, tips of the upper horns, the upper portion of the pyramidal process, and finally almost any part of the neck, including the lateral and subclavicular areas, must be investigated. The danger of parathyroid and nerve damage is distinctly greater than in primary cases.

POSTOPERATIVE COMPLICATIONS

Postoperative hyperthyroid reaction. Ten years ago I wrote: "The basic fault in the scheme of operation is to leave behind an amount of (pathological) thyroid capable of such excessive action." The radical operation here described is intended to avoid just that error.

Iodine has served greatly to reduce the incidence of postoperative reactions even with less radical procedures. When reaction occurs, large doses should be given and liquids pushed, rectal and subcutaneous routes being utilized. Crile has shown the danger of hyperpyrexia and the value of ice packs should it develop.

Postoperative bleeding and hæmatoma. This accident is relatively frequent and the amount may vary from a small infiltration to a serious hæmorrhage with pressure. The bleeding may result from venous oozing or from active arterial bleeding. In any case, with material hæmorrhage or the formation of a sizable hæmatoma, complete reopening of the incision and evacuation of the clot is essential. In the presence of active arterial bleeding, timid approach is dangerous.

The cause of active arterial hæmorrhage is not always careless ligation. Altered vessel walls quite possibly are a factor in permitting a vessel to give way at the site of ligation.

Tetany. In the first days following thyroidectomy, patients are uniformly examined for the presence of the Chvostek or Trousseau signs. The presence of these as indicating postoperative tetany is further confirmed by Erb's electrical reaction and the determination of the blood calcium.

Mere tingling or other mild discomfort is best treated by the elimination of meats and meat products from the diet and the giving of milk freely. Calcium in large doses is effective—calcium lactate may be given in 30 to 45 gram doses daily in milk or wafers. If given before meals on an empty stomach, much smaller doses suffice.

If tetany develops to a substantial degree with spontaneous spasms, parathormone (Collip) should be given hypodermically at once—usually two or three doses sufficing, and the diet as above maintained. To this diet 200 grams of lactose daily should be added.

The combination of calcium, lactose, milk, and meat-free diet will control any case. If the symptoms persist, parathormone should be given from time to time to permit some comforting relaxation of dietary restriction. Ultimate recovery is the rule. Rarely, symptoms may persist for years.

The value of ultraviolet light and the various radiated oils, etc. is now being investigated.

Recurrent laryngeal nerve injury. This complication should be detected on the operating table and appropriate measures at once taken to sever ligatures which may have included the nerve. Occasionally a hæmatoma may give rise to pressure symptoms involving the nerves. Evacuation of the clot usually is followed by recovery.

When the injury is unilateral, time will improve the patient's condition. If incomplete, recovery will follow. Complete bilateral injury causes permanent disability. Œdema of the cords resulting from trophic disturbances may render tracheotomy necessary. There is often remarkable freedom from dyspnœa except on exertion. The voice may also be very satisfactory except for inability to raise it to a higher pitch. Occasionally postoperative tracheitis may be confused with recurrent laryngeal nerve damage—the diagnosis is made by laryngoscopic examination.

Exophthalmus. Exophthalmus, developing or increasing as a postoperative complication, is a most perplexing and, at times, serious condition. It is usually associated with hypothyroidism. Marked œdema of the conjunctivæ with lacrymation may be present. The deformity is unsightly, the discomfort may be disabling, and corneal ulceration has developed. There is some tendency to recede, but progress is slow.

Treatment has been unsatisfactory. Metabolism should be maintained at normal. Iodine has been suggested. Large glasses or goggles as protection are important. We have had no experience with sympathectomy or orbital operations.

Hypothyroidism—postoperative. The type of radical thyroidectomy advocated in this paper will result in a high incidence of temporary hypothyroidism. This is to be desired for it definitely insures against failure to accomplish the surgeon's purpose—permanent relief from thyrotoxicosis. Gradually, the process requiring from several months to a year or more, most patients return to normal. The period of hypothyroidism is one of discomfort that can be avoided by starting the patient on desiccated thyroid about the fourth week, varying the dose to meet requirements. Clinical symptoms and frequent basal metabolic determinations are the best guides.

EFFECT ON THYROTOXICOSIS AND METABOLISM

The thyroid is essential to the existence of thyrotoxicosis. A sufficiently radical thyroidectomy must necessarily end the intoxication. Residual organic damage may remain but not active intoxication.

The effect on the basal metabolism is the best single means of estimating the effectiveness of the thyroidectomy and of comparing results of treatment with other methods. For the purpose of this paper a recent consecutive series of 500 thyroidectomies was studied for the effect on metabolism. Only patients showing a substantially raised metabolism were included. Exceptions were patients thoroughly iodized just before coming under observation. Including these, less than 15 per cent were below plus 30. The average preoperative basal metabolism was approximately plus 46. Postoperative metabolism studies were made on 447 of these patients. Of these 443 were found to have a metabolism of below plus 15. Of the 4 whose postoperative metabolisms were above plus 15, one was a single metabolism of plus 16. One has been consistently normal, but at the last check up, too late to be repeated in time for this paper, he had a plus 20. He is probably not toxic. One has had a postoperative metabolism of plus 15 and plus 20 within 5 weeks of operation and is no longer available for further check up of her metabolism. One has had five postoperative metabolisms, all consistently above normal, ranging from plus 20 to plus 22.4 and is probably mildly toxic. Thus there has been one definite failure to secure normal metabolism in 447 consecutive patients available for study.

None of this series of 500 patients was subjected to a two step operation; one had a preliminary ligation. Many had been previously operated upon unsuccessfully elsewhere.

MORTALITY

The very radical thyroidectomy has given a consistently low mortality. Before the introduction of iodine, it ranged about 1 per cent. Since the introduction of iodine, the mortality has been further substantially reduced. There has been but one death in this series of 500 cases; more than 400 patients have been operated upon since the last death. There has also been a previous series though overlapping this series of well over 500 consecutive thyroidectomies with one death. Both series refer to patient mortality.

This low mortality is based on the principle reiterated above, of leaving so little thyroid behind that postoperative reactions are prevented, and on an entire avoidance of "step" operations.

FROM THE DEPARTMENT OF SURGERY, UNIVERSITY OF CALIFORNIA

CHOLECYSTECTOMY—MODIFICATIONS IN TECHNIQUE

STANLEY H. MENTZER, M.D., AND JOHN HOMER WOOLSEY, M.D., F.A.C.S., SAN FRANCISCO, CALIFORNIA

IN 1890 Courvoisier reported that 47 cholecystectomies had been performed to date. Since then cholecystectomy has become an accepted procedure although there have been many modifications in the methods of gall-bladder excision. Even today the technique of cholecystectomy is not standardized, nor can it be, for anatomical and pathological reasons.

INCISION

The choice of incision is great. The Bevan type has its admirers, the costolateral incision of the Mayos' gives excellent exposure, the transverse incision as used by Quain is very satisfactory, the ordinary right rectus incision has been employed at the University of California Clinic for years with great satisfaction, and more recently the new incision by Sloan permits equally as excellent exposure as any of the foregoing.

The one requirement of the incision, granted that it will admit exposure of the right upper quadrant of the abdomen, is that it must be sufficiently large to allow the hand of the assistant to enter for retraction and still leave space for handling the gall bladder with modern instruments under direct vision. An ordinary right rectus incision 14 centimeters long is quite satisfactory.

EXPOSURE

The ease of all biliary surgery depends upon the exposure (Fig. 1). It is obtained in a very simple but definite manner and yet, from our observation, is not well understood. The secret is in the manner of placing the moist tape-pads and the manner in which the assistant holds his left hand so as to retract the stomach, duodenum, omentum, and hepatic flexure of the colon. Moynihan has said regarding this maneuver: "The placing of the hand in the exact position necessary to secure gentle traction of all viscera away from the common duct is in many respects the most important single detail in the operation." It is done in this manner: One or two moist tape-pads are placed over the hepatic flexure of the colon and forced gently downward; a second and sometimes a third tape-pad is placed along the mesial side of the gall-bladder fossa so as partially to force the omentum and stomach to the left; another tape-pad is now spread out over the duodenum and pyloric region of the stomach, and against the latter, the assistant, who stands to the left of the patient, places his left hand, with the fingers well spread apart. Gradually the assistant works the fingers of the retracting hand down to the posterior abdominal wall, hooks them and then retracts the viscera along the mesial side of the gall-bladder fossa well over the left. As a rule the entire hand will need to be within the wound with the palm being utilized as the body of the retractor and the fingers slightly hooked so as to give greater tension or to increase tension on the stomach, colon, and omentum at the base of the operative exposure. This maneuver, with the hand flexed at the wrist, allows the entire hand to be utilized in the retraction. The fingers placed in deeply against the posterior abdominal wall with slight hooking prevents what usually occurs, a creeping back of viscera at the base of the operative exposure.

The success of the exposure is dependent more upon this maneuver and the maintenance of it than on all other steps. It is well also to place a small amount of gauze packing in the very bottom of Morrison's pouch, for it serves to absorb any bile that might accidentally spill during the operation and also serves as a contrast in color, thus aiding in the identification of the overlying structures of the cystic duct region (Fig. 2).

The severance of the round ligament of the liver and traction upon this will at times be of tremendous aid in eventrating the liver and in maintaining the exposure thus exposed. The use of the operating table "kidney" lifts, pillows, breaking of the table to aid in exposure of the liver, and the use of gauze packing in the intraperitoneal space above the liver to hold it partially eviscerated are as a rule, in our opinion, unnecessary.

Finally, a relatively broad hæmostat, such as a 5-inch Péan (Mayo pattern), is placed upon the neck of the gall bladder for traction purposes. If the surgeon now pulls gently upon this hæmostat the cystic duct region will be put on stretch. The assistant, coincidentally, with a sponge stick in his right hand, presses the edge of the lesser omentum in the region of the cystic duct mesially. This gives an excellent exposure of the operative region.

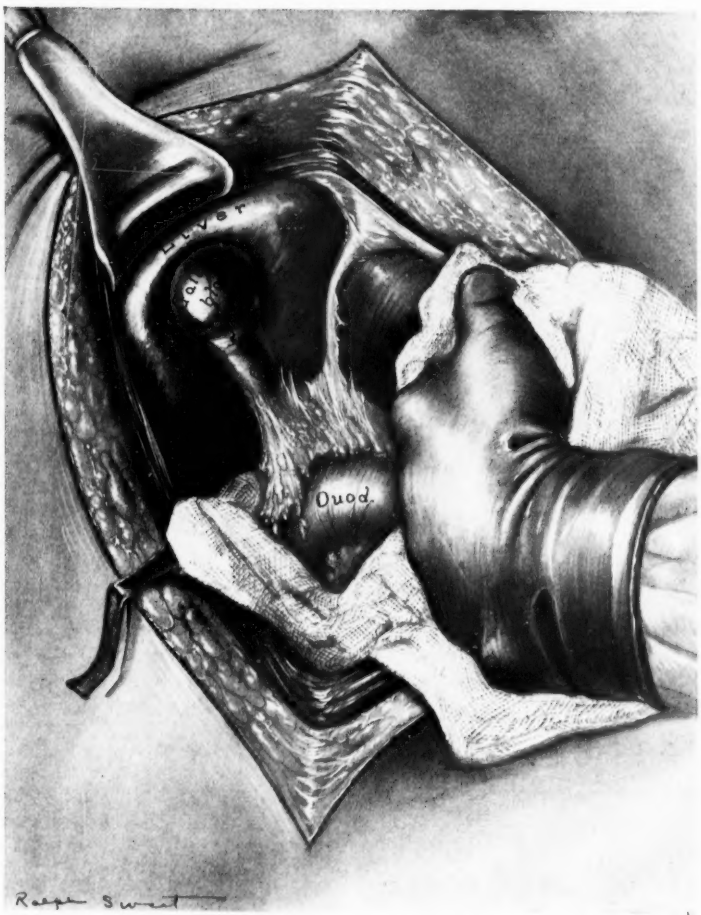

Fig. 1. Exposure obtained with the use of the entire hand.

IDENTIFICATION OF THE BILIARY DUCTS

Flint has demonstrated that the biliary apparatus of only about 30 per cent of persons conforms to the "normal" as pictured in the texts of anatomy. The marked variations in the duct and vascular arrangements of the biliary tree make it imperative to identify the major structures before irreparable surgery is performed. This can be accomplished only by exposing the ducts adequately. The cystic duct should be liberated from the adjacent tissue until it can be traced from the gall bladder to its junction with the efferent duct. This latter may be the right or left hepatic duct, the common hepatic duct, or the duodenum. The cystic duct may make a partial or complete circuit about the right hepatic duct or even around the common duct and so bewilder one in its course that identification is possible only after complete exposure.

The common duct is occasionally indistinguishable from the portal vein or from a right or left hepatic duct, especially one that has its termination close to the ampulla of Vater. Identification is often difficult because of adhesions or adjacent inflammatory structures. In these instances the bile duct can be definitely recognized by exploration with a syringe and small needle, aspirating from the structure in question.

There is often a peritoneal fold extending well up onto the gall bladder and at times to the

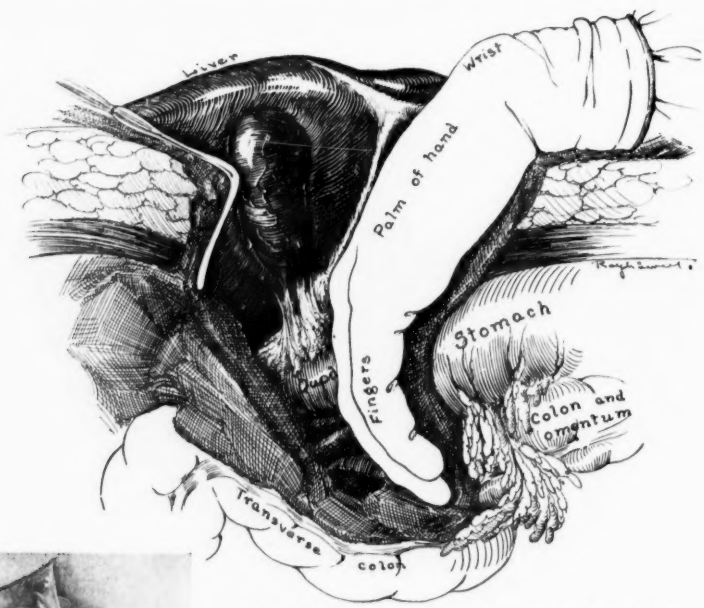

Fig. 2. Profile view showing the retracting hand in place and fingers hooked.

Fig. 3. Extension of lesser omentum over on to gall bladder.

duodenum. This fold is a prolongation of the lesser omentum but is frequently wrongly interpreted as evidence of inflammatory changes (Fig. 3). This is found in about 12 per cent of routine autopsies.

The peritoneum and underlying fat is then incised and stripped away from the duct so that their courses can be adequately traced. This is best done by blunt dissection. We expose the cystic duct to its junction with the efferent duct and identify, if in doubt, the course of the right hepatic duct from the liver. If this is done no mistake can be made in ligating the proper duct.

LIGATION OF THE DUCTS AND ARTERY

Little difficulty is encountered in clamping the cystic duct if it is long and empty. The short duct, however, especially when filled with small stones, may prove troublesome. We have found the small right-angled clamp of Mixter helpful. The duct, already isolated, is elevated by hooking the L-part of the clamp under it. A similar forceps grasps the duct about 0.5 centimeter from its juncture with the common duct and a second clamp (usually the one used to elevate the duct) is placed parallel and distal to it. The duct is severed between clamps with a scissors or knife. It is rarely necessary to

Fig. 4. Manner of double ligating the duct with transfixation-duct-suture.

use a cautery or to sterilize the cut end of the duct, for bacteriologic studies have shown that bile is as a rule sterile and the duct walls free of organisms. In cases of acute empyema or cholangitis, however, cauterization is advised.

The cystic artery, when it lies close to the cystic duct, is caught and tied with the latter. As Eisendrath and others have shown, however, the cystic artery has so many anomalous courses and branches that it is often not secured in this manner. Therefore, in such instances, a careful study of the fatty tissue immediately behind the cystic duct should be made. Certainty of ligation of this artery is important for severe hæmorrhage may otherwise occur.

We have tried many methods of ligating the duct and artery and have found that a single strand of No. 1 chromic catgut tied with three knots, that is, a re-inforced reef knot, is best. We secure it in place by a transfixation-duct-suture adapted into a second circumferential ligation on the duct distal to the first (Fig. 4). The second knot is thereby held securely in place, and the first knot is unable to slip off because it is held in place by the second. The suture does not endanger bile leakage for there is ligation proximal to it. The artery is likewise at times doubly tied. As a further precaution, the omental edges are often stitched with a suture or two over the stump of the cystic duct. In this way every possible oozing point is secured and there is no possibility of bile leakage from untied accessory ducts other than those entering the side of the gall bladder from the liver in the gall-bladder fossa. Although these are not common they are diligently searched for and tied before the liver fossa is peritonealized.

REMOVAL OF THE GALL BLADDER

McWhorter, in describing the dissection of the gall bladder, remarked: "Where the tissues are

Fig. 5. Injection of fluid in the gall-bladder bed to aid in dissection.

œdematous and the gall bladder thickened and friable, the tissues separate very readily." Œdema thickens a fatty, connective type of tissue, gives thereby a wider space for dissection, and aids the finger or the instrument, if desired, in finding more easily a line of cleavage. One can produce such an œdema between the gall bladder and the underlying liver by injecting normal salt or Ringer's solution just beneath the gall bladder (Fig. 5). Dexterity in this procedure is easily acquired by experience. It is of especial advantage in cases of moderate cholecystitis or of cholesterosis. The complaint that it temporarily blocks blood vessels, allowing hæmorrhage later, has not been found to be true in our experience. On the other hand, in the dissection of the gall bladder from the liver, it is of aid in protecting blood vessels of any size from breaking off flush at the liver and will, as a rule, leave a protecting layer of loose connective tissue in the gall-bladder fossa. Leakage of bile from exposed liver radicles occurs rarely, certainly far less than with the usual dissection. Therefore, just preceding the dissection of the gall bladder from the liver 10 to 20 cubic centimeters of normal salt solution is injected with a 6 centimeter needle so as to infiltrate the entire gall-bladder bed, the injection beginning at the fundus and gradually advancing.

The peritoneum, which is reflected from the liver upon the gall bladder, is now severed so as to allow approximately 0.5 centimeter, or even more, to remain on the liver side. Then the clamp upon the duct is held taut and the index finger gradually separates the gall bladder from its bed. In many instances the peritoneal flaps will completely cover the dissected gall bladder fossa and be

folded in naturally by the apposing liver edges when all traction is ceased and the liver allowed to return to its normal position. Otherwise a running suture of No. 00 plain catgut approximates the peritoneal flaps over the raw area.

Blood vessels, if sufficiently large, should be ligated, but parenchymatous oozing can, as a rule, be quickly controlled by a hot, moist pack left in contact with the area operated upon for the ordinary clotting time, three minutes.

DRAINAGE

We have found it possible to close the abdomen without drainage in about 70 per cent of our cases. When drainage seems advisable we prefer rubber dam (Penrose type) or occasionally a dressed tube, brought out high up through the abdominal wall by way of a lateral stab wound. Separation of the wound edges occasionally follows drainage through the operative incision.

Most of our cholecystectomies are performed under nitrous oxide-oxygen or ethylene anæsthesia. With ether anæsthesia, bile flow is retarded, and the finer bile channels can be severed without cognizance. Occasionally when the patient has awakened from this type of anæsthesia and when the liver begins to function actively again, a biliary peritonitis may occur and even reoperation become necessary. With nitrous oxide-oxygen anæsthesia and apparently with ethylene the liver continues its activity, and severed bile ducts, especially in the liver fossa, can be detected and ligated before the abdomen is closed. This is, of course, the most important feature of non-drainage (Fig. 6).

Drains leading directly from the stump of the cystic duct are apparently responsible for bile leakage in many instances, probably because of irritation or erosion. Long catgut strands left after tying the duct and used as drains have been pulled off with dressings and the catheter drain threaded over these long ends has been especially pernicious. Drains of these types only irritate the duct stump and predispose to bile leakage. For this reason we cover the stump of the duct with omentum and lead rubber dam or cigarette drains from the liver fossa rather than from an area near the cut end of the duct.

SUMMARY

1. The method utilizing the hand to retract the mesial side of the wound and operative field is the most important point in the exposure.

2. Absolute identification of the biliary ducts is essential.

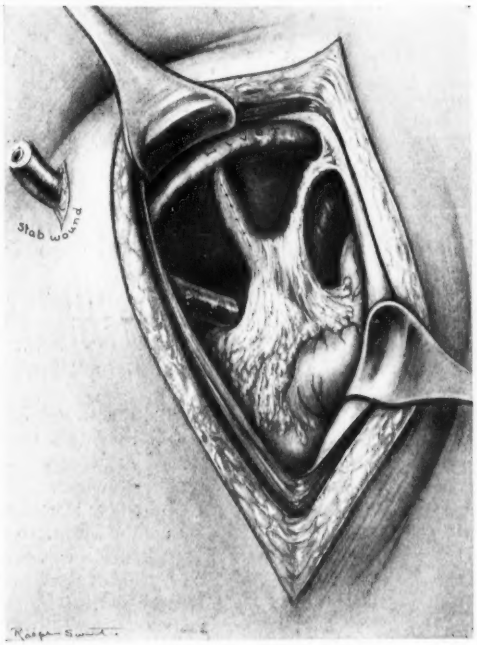

Fig. 6. Drainage by stab wound.

3. Double ligation with the transfixation-duct-suture of the severed duct insures permanent closure.

4. The injection of the gall-bladder bed with an isotonic fluid aids in the dissection.

5. Closure without drainage is preferred whenever possible.

6. Drainage by a high stab wound rather than through the operative incision offers a better opportunity for primary closure.

7. The use of gas-oxygen or ethylene anæsthesia instead of ether assists in determining the dryness of the operative field.

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THE USE AND USES OF LARGE SPLIT SKIN GRAFTS OF INTERMEDIATE THICKNESS[1]

VILRAY P. BLAIR, M.D., F.A.C.S., AND J. B. BROWN, M.D., ST. LOUIS, MISSOURI
From the Department of Surgery, Washington University Medical School

EARLY, quick, and permanent surfacing of burns and other cutaneous defects conserves health, comfort, function, time, and money; while unnecessary waiting spells economic waste.

The factors that might lead to a choice between the use of flaps or of free grafts are not presented here, but having decided in favor of the latter, we should give serious consideration to the type of skin graft to be employed.

Next to the pedicle or sliding flap, a successful free skin graft of practically full thickness will most closely duplicate the natural surface, but a number of circumstances must be considered in each case: the type of the graft best fitted for the particular loss, the speed of the operation, the source of the graft, and the potential healing qualities of the patient—all have a bearing.

The full thickness graft is appropriate for a freshly made, clean raw surface where substantial protection, maximum mobility, minimum of subsequent contraction, and the most natural appearance are essential to a successful result. Circumstances permitting, the full thickness graft has usually been chosen to cover a contracted, healed surface, in which the full thickness of the scar must be cut through or removed to allow relaxation. Such an area may be situated on the front of the neck, on certain parts of the face, over the flexor surfaces of joints that can be extended, or the extensor surfaces of joints that can be flexed. The full thickness graft is also used in the correction of webbed fingers and for the release of arms fixed and grown to the trunk as the result of a burn. On fresh granulating surfaces, on freshened scar surfaces in contradistinction to scar surfaces which have been completely excised, on surfaces that will resist subsequent contraction or in which allowance can be made for such contraction, if the appearance and demands of function do not contra-indicate their use, thinner grafts are chosen because of the comparative simplicity of their application and the greater certainty of the "take." On the back of the hand, except over the knuckles and upon the subcutaneous muscles of the face, the orbicularis oris and orbicularis palpebrarum, a split graft of some thickness is, in most cases, the one of choice. Circumstances may make it necessary to vary any of these rules. The technique of application of the full thickness graft and its after-care are both exacting and time-consuming. The graft itself is very susceptible to infection so that the patient must possess good healing power. The wound produced by the removal of the full thickness graft must subsequently be closed.

The Ollier-Thiersch graft is theoretically supposed to include little more than the epithelial layer.[2] If given half a chance such grafts will heal in close to 100 per cent in areas which are only relatively clean and in patients with somewhat lessened healing power. While it requires considerable time and skill to obtain a good full thickness skin graft of any size, very large thinner grafts can be quickly cut, and, if one does not go too deeply and the dressing is properly applied, the resulting raw area is usually healed within 10 days when the first dressing is removed. In most instances it requires 3 weeks of exacting postoperative care to carry through a full thickness graft, but the successful thinner graft at most requires only protection for a few days after the primary dressing is removed. In many cases, moreover, if one wishes to form a lining for the antrum or for the conjunctival sac or to form a surface over de-epithelialized derma or the orbicularis oris or orbicularis palpebrarum, this lack of thickness of the graft is a very desirable quality.

Three factors associated with the use of the thinner graft, if inaptly applied, may seriously affect the final result: (1) the thinner graft may not give sufficient protection to a bearing surface; (2) the thinner graft, because of its thinness, will not correct the inequalities of the underlying surface; and (3) the thinner graft, if placed on a freshly made raw surface with a movable base and movable edges, such, for instance, as the subcutaneous tissue of the neck, may subsequently contract without any loss of epithelium, and the contraction may be as much as 60 per cent.

Contraction does not take place in the graft itself but in the layer of scar tissue which unites the graft to its new bed. In the full thickness graft the derma seems to a large extent to have the power to resist this potential contraction. If the

[2]This type of graft was described by Ollier in 1882 and by Thiersch in 1886. Lawson (1881) and others had used free grafts larger than Reverdin grafts previous to these dates.

[1]Read before The Southern Surgical Association, White Sulphur Springs, West Virginia, December 11-13, 1928.

Fig. 1. Covering of a granulating surface that resulted from the removal of a flap. A, left. The process of restoration of the lining of the cheek following the destruction of a wide spread verrucous growth of the buccal mucosa in a patient 34 years of age. This case is an excellent instance of the advantage of an available speedy method of covering defects from which flaps have been taken. If drawn together or allowed to heal these defects are ugly and, in this instance, would have distorted the neck tissues. The cheek wound was closed and the remaining part of the flap was returned to the neck. The granulations were then cut off down to a yellow scar base and a thick split graft sewed into place and fixed with a roll of gauze sutured firmly over it. B. The result of grafting after about 2 months.

thinner graft is laid on a freshly denuded scar base, on derma, on the periosteum, or on bare bone, or if the grafted area is surrounded by tense skin or scar, there may be little subsequent narrowing of the field. If the thinner graft is cut so as to include an appreciable amount of the derma, it seems to possess more of the good than the bad points of either the full thickness or the true Ollier-Thiersch graft, and it is this type of graft which we shall discuss here.

Having categorically presented the shortcomings of the thick split graft it is only fair to reiterate its redeeming qualities. A graft of this type of large size can be easily obtained with relatively little damage to the area from which it is cut, the "take" is almost certain, and, if judiciously used, such a graft gives good protection and a fair final appearance. A graft aggregating one hundred square inches will heal as quickly and surely as one an inch square and not a great deal more time is required for the cutting. Further, unless one cuts too deeply the defect resulting from the removal of one hundred square inches or more of graft will heal as quickly as that from a square inch graft. The more accurately and evenly the grafted area is covered the more will the result approach the normal condition.

TECHNIQUE

Preparation of areas to be grafted. Acute purulent skin eruptions or acute pus infections of any kind are contra-indications to any plastic operation, and especially to free skin grafting. Therefore, a careful examination of the skin of the entire body is made before and on the morning of operation. A pimple or a boil, even on a remote part of the body, with sufficient induration to suggest the possibility of tissue necrosis or "core" formation, means that the host's resistance to that organism is low at that particular time; and we regard such a remotely located pimple, boil, or impetigo as a contra-indication to skin grafting. Acute tonsillitis is also a contra-indication. Almost all of the failures in our experience we have attributed to an unrecognized or an immediately developing infection of this kind. The chronic acne pustle, the simple inflammation about a comedo, and the acute pustule without induration are not regarded as sinister and receive little consideration unless they are located on the field of operation. During the periods of preoperative preparation all pustules, as they appear, are treated by means of small pieces of adhesive plaster placed over them and allowed to remain until the lesion dries up or discharges. Autogenous vaccines are used for recurrent staphylococcus infections; for the staphylococcus aureus hæmolyticus infection we have used the specific antitoxin recommended by Parker and prepared by Eli Lilly & Com-

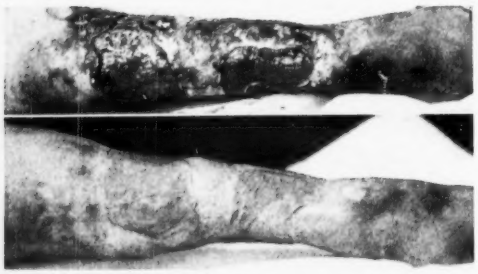


Fig. 2. Ulcers in a heavy scar base, primarily luetic, 20 years' duration without healing. A, above. For 10 days a wet dressing was applied to the leg every day in the out patient department to save this amount of hospitalization. The patient, a woman aged 34 years, was then kept in bed in the hospital for 3 days and the dressing changed twice daily. At operation the areas were excised including the indolent edges all around. After clean excision of each ulcer base there remained a smooth, yellow scar base that bled profusely. This bleeding was stopped by means of compresses held on while the grafts were being cut. The grafts were cut from the thigh, the suction retractor being used, and were made large enough so that only one graft was necessary for each area. They were sewed in place under normal tension, multiple holes were stabbed through them, and a firm sponge pressure dressing was applied. A posterior plaster shell was then put on for support. B. The leg 1 year later. There was practically a full take and healing was complete in 10 days. This was the first time the patient's leg had been healed for 20 years. She was kept in bed for 3 weeks after operation, and arrangements were made for convalescent care so she could continue to keep her legs at rest, because it was thought that the enforced rest was an important factor in the successful outcome. She remained at the convalescent home but one week, however, and returned to her household duties. Supportive bandages were worn and she got along splendidly. A piece of adhesive was pulled off her leg after she was discharged from the hospital, and a small ulcer developed in an area adjacent to one of the grafts. This area was cleaned up and successfully grafted 4 months later. She is now seen regularly, a supportive bandage is worn, and she is encouraged to stay off her feet as much as possible. She is thoroughly appreciative of the relief from the 20 years' burden of the ulcers. On these scar surfaces where the skin is thin and of poor texture adhesive should not be applied, and when crusts or scales form they should not be picked or scraped off but left alone or covered with a mild ointment.

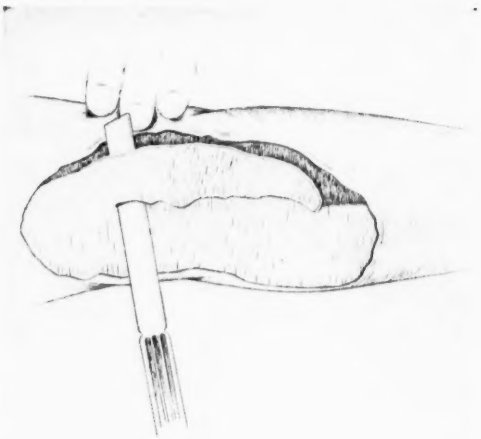


Fig. 3. Shaving off granulations. Checked up observations show that the "take" would average much nearer perfect on a scar base prepared by shaving off granulations than on the natural surface of granulations. The granulations are not scraped but sliced cleanly down to a firm yellowish scar base which is found below the depth of the velvet. Before the area is sliced, it is outlined with a scalpel just within the surrounding skin or scar, so as to give a definite sharp outline to the denuded surface. Surfaces covered with healed scar are removed in the same fashion, the surface scar epithelium being cut off first and then the deep scar sliced through, layer after layer, until a yielding, well vascularized, deep level of scar is exposed. When this decortication is completed, if the defect is surrounded by normal skin, it will have expanded approximately to the size of the original defect and this will allow the distorted surrounding parts to return to their natural positions (Fig. 16).

pany. Ultraviolet radiation and blood transfusions are frequently resorted to, and every effort is made to improve the general hygiene of the patient with particular attention to exposure to sunlight.

For preparation of healed cutaneous areas, ordinary cleansing care, the removal of all scurf or scales the day before operation, and the use of some antiseptic solution in the operating room are sufficient.

Unless the staining is objectionable, picric acid is used on surfaces that will not be exposed. On the face, neck, arms, and hands, iodine, 3½ per cent, is applied twice and removed with alcohol. If the graft is to be near the eye, the conjunctiva should be prepared by the application of fresh 1 per cent mercurochrome. In operations about the face done under local anæsthesia, before the field of operation is prepared, 2 drops of 4 per cent cocain are put in each eye to prevent pain should the iodine and alcohol enter the tarsal fissure.

On a moist mucous membrane it is questionable whether a single application of a chemical solution is more effective than a simple douche. A healthy mucous membrane is very resistant to traumatic infection and needs no surface sterilization. The mucosa, especially of the nose and mouth, is more susceptible to chronic inflammation than is the skin, and if any preparation other than simple cleansing is indicated it should be in the form of treatment rather than in an attempt at direct sterilization. We do use weak chemicals in the conjunctiva but put little reliance in them except as a douche. We use iodine in the vestibule of the nose because it is skin lined. In the absence of acute inflammation, we believe that it is permissible from a practical standpoint to regard organisms even in a foul mouth as not pathogenic to that person at that time. We do not operate in the presence of an acute inflammation

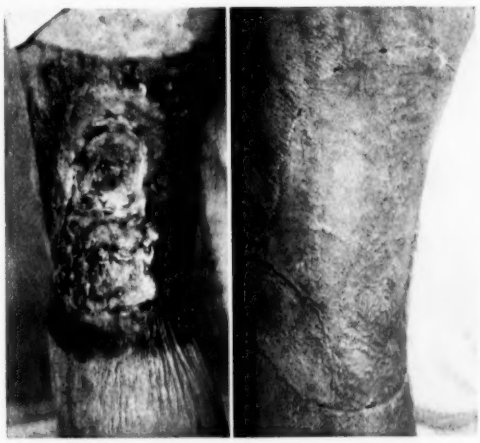


Fig. 4. Burn scar, spontaneous ulceration 50 years later. Clinically cancer, unconfirmed by microscope. A, left. Chronic ulcer which had been present for 5 years in the scar of a burn the patient had received at 5 years of age. He is now 60 years old. The process appeared malignant clinically and there were large gland masses in the groin. The discoloration is due to mercurochrome which was used in cleaning up the ulcer. Amputation was advised but refused. Under local anæsthesia, the whole area was excised with a cutting cautery which penetrated the popliteal fascia in places. This allowed retraction of the surrounding skin edges and the defect opened up to about one-half again as large as shown in *A*. This relaxation also allowed full extension of the leg. Balsam of Peru and iodoform gauze were sewed over the defect and a posterior plaster shell put on. This dressing was removed on the eighth day and mercurochrome packs were reapplied. Four weeks after the first operation, the apparently clean granulating wound was covered with grafts taken from the abdomen and chest, after the granulations were sliced off as described in Figure 3. Healing was complete in 2 weeks. B. Result 5 months later.

Fig. 5. The abdomen as a source of split grafts. The abdomen, of the patient whose leg is shown in Figure 4, showing the wide areas from which grafts can be cut with the aid of the suction retractor. There were only a few raw places left at the time this photograph was taken 10 days after the cutting of the grafts. We prefer to use general anæsthesia when such grafts are cut. Even in debilitated patients, probably less shock results than if an attempt is made to infiltrate a large area with novocain. A light analgesia is sufficient, and with nitrous oxide the patient is usually awake and co-operative at the time the grafts are sewed on, if this part of the operation is done under local anæsthesia. We have been able to cut grafts with the patient fairly deeply under hyoscine and morphine, but this procedure is not uniformly applicable.

of a sinus, of the tonsils, of the mucosa, or about a tooth. We avoid turning subacute infections about the teeth into acute conditions by what might be called ill advised trauma, the result of too energetic mechanical cleansings or extractions. We ordinarily regard as sufficient preparation the cleansing of the mouth with the tooth brush and a soapy tooth paste and with a simple mouth wash such as hypertonic salt solution.

The preliminary preparation of bare and granulating areas including indolent ulcers. Unless it is the site of an aggressively active infection or of a locally impaired circulation, a granulating surface will, in time, epithelialize spontaneously; but, except for small defects, this is a waste of time and money. Ordinarily, in a patient of fair health, sluggish or dirty granulations can be quickly cleansed by absorbent dressings dampened with some sort of an aqueous solution changed every 8 hours, by rest, and by postural control of the return circulation. So long as it is non-irritating, the exact nature of the solution is probably not of great consequence. The important factors are: (1) that the dressing be damp and absorbent, not sloppy or allowed to dry in place; (2) that it be changed sufficiently often; (3) that it be firmly and comfortably applied. Regardless of the chemical content of the solution, the primary object is continuous drainage and pressure control of the circulation both within the granulations and in the associated area. Where the facilities are available and the staff is familiar with the technique, chemical sterilization checked by frequent counts is undoubtedly a valuable adjuvant to wound cleansing and healing, but unless accurately done and unless its true objective and its limitations are appreciated it may cause more harm than good. In the Carrel-Dakin technique, the fluids bathe the raw surface directly and moisten the gauze secondarily, which probably accounts for its high average of effectiveness when properly applied. Fluids repeatedly

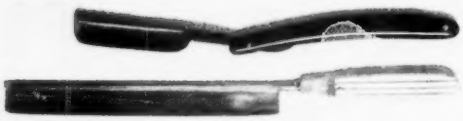


Fig. 6

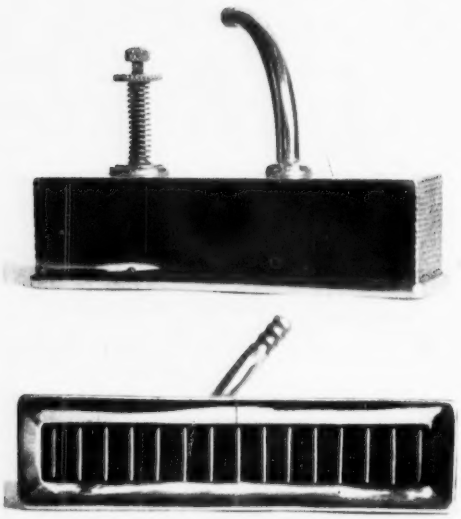


Fig. 7

Fig. 6. Knife and razor. The blade of the knife is 18 centimeters long and 2 centimeters wide. It is made of a strip of razor steel set into a stiff back and the whole thing is made very light. It can be stropped on a piece of canvas, but will have to be ground occasionally. The razors are regular barbers' razors with the heel and toe rounded and sharpened so as not to hang in the skin while being used.

Fig. 7. Suction retractors. These are hollow brass boxes with the underneath side open for application to, and suction on, the skin. Boxes of three different lengths of opening are used—4.5, 7, and 9.5 centimeters—for application to different areas, the smaller one being especially useful for obtaining grafts from the abdomens of infants and children. Just within the opening there is a series of transverse bars which prevent the skin from being drawn bodily up into the box. The ends are corrugated for gripping and are 2.5 centimeters square. A tube leads from the top of the box to be connected to a non-collapsible rubber tube connected to a strong suction machine. There is a spring valve on top of the box with a screw for the adjustment of the strength of suction. The suction usually used is a half of an atmosphere of negative pressure.

Fig. 8. Use of the suction retractor. We always feel apologetic for using a special instrument but believe this suction retractor has some justification. While this machine, in its present form, is not a substitute for manual dexterity in cutting grafts, repeated comparisons have convinced us that with it, one is enabled to cut grafts more quickly, to make them larger and of more uniform thick-

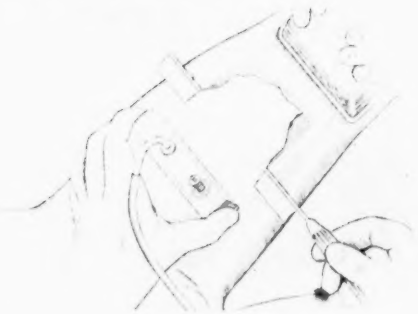


Fig. 8

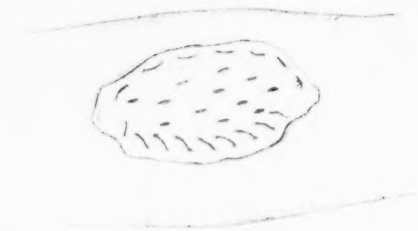
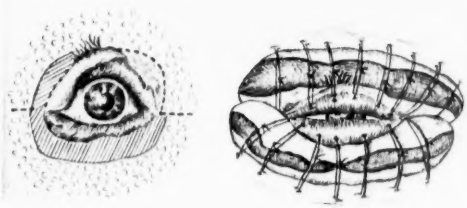


Fig. 9

ness, and to make them of almost any desired thickness—all of which widens the field of usefulness of these grafts. It also enables one to cut large grafts from areas that ordinarily cannot be made available as sources of split grafts, such as the rapidly moving abdomen of a young baby. A very thin film of vaseline is applied to the donor area and gently wiped off with a gauze sponge. Too much vaseline allows the box to slip too easily; with too little it will drag and cause ecchymosis. One end of the field is fixed with the edge of a flat pan in the hands of an assistant. The knife as shown in Figure 6 is used. The suction retractor is drawn slowly along the surface, neither raising nor depressing the skin. However, when grafts are cut from the abdomen it may be advantageous to lift the skin slightly to get the correct tension. In the present form if the box is allowed to remain stationary in any particular place, or is moved too slowly along the skin, too much pressure may cause streaks of dermal œdema, which will be registered in the form of thicker streaks in the graft.

Fig. 9 Sewing on graft. Application of graft to prepared surface. It is cut large enough to overlap the edges (which may be reefed back on themselves to enlarge the area grafted and thus try to prevent subsequent edge scar) and is basted or whipped into place all around with a running horse-hair stitch, practically normal tension being maintained on the graft at all times. Whipping into the edge of the defect is probably the more satisfactory. Multiple stab wounds are put through the graft with a pointed knife to allow the escape of blood and serum. (These allow slight relaxation of the graft.) Before the dressing is applied any blood clots underlying the graft are expressed from beneath it with a roll of gauze. These thick grafts may leave a more pronounced scar along the edge than the regular Thiersch graft, but as shown in many of the illustrations, they usually flatten out satisfactorily; in fact the excess thickness may even tend to prevent keloid formation.

A. D. E.



B. C.

Fig. 10. Total destruction of skin of the face and obliteration of anterior nares. At one sitting the left upper and lower lids and the nasal cavity have been restored with thick split grafts. A. Photograph taken 1 year after beginning active treatment. This patient, a woman aged 59 years, had allowed luetic destruction of the face to proceed for 3 years. The ulceration has stopped and there is complete scar healing but there is complete ectropion of all four lids and both lips, the external nose is all gone, the nasal passage for a depth of more than a centimeter consists of a fistula about 3 millimeters in diameter, the skin of the face is totally lost, being replaced by typical satiny scars. In the inner half of the upper lid part of the tarsal border was preserved; in the outer half the mucosa blended smoothly with the scar on the supra-orbital border. In the lower lid even less of the tarsal border could be made out. B. The approximate amount of scar surface removed is shown by the striped area; the incisions are marked by continuous lines; the amount of superficial undermining is indicated by the stippled area; the approximate location of the sutures that draw the tissues around the graft covered wax forms is indicated by short dashes. C. The graft covered wax forms in place and the sutures drawing the lids around them. For the sake of clarity of the illustration the lids are not shown drawn out as far as they should be. These wax forms are so shaped that when in place they are braced against each other so that they do not press on the globes. By this precaution both lids can be grafted at one sitting. D-E. Condition 20 days after operation showing a single nasal passage of sufficient size preliminary to making a new external nose, the amount of opening and closing of the lids, and the area grafted. The operation here shown conforms in a general way to the plan described by Gillies under the heading of out lay graft of the eyelid.

applied to the surface of infrequently changed overlying gauze probably have little douching effect on the raw surface and may never penetrate the film of secretion which normally coats all granulating or infected areas. Unguents, while they do not impede circulation, seem to lack the desired stimulation to granulation (Figs. 1 and 2). Bad odor can usually be killed by a simple application or irrigation with a 1 or ½ per cent solution of formalin preceded by an application of weak cocain to prevent pain or the use of gauze impregnated with balsam of Peru and iodoform. A paste of lactose and dextrin in buttermilk to produce the bacillus acidophilus is a more complicated and less sure way to obtain the same result.

Success or failure in the use of grafts will depend more upon the healing qualities of the tissues than upon all other factors and influences combined, including good surgical technique. To secure the maximum benefit from a chemical antiseptic applied to the skin or raw tissues, it is imperative that special attention be given the primary factors already mentioned, and if the strength of the solution lessens tissue resistance then it is best to discard it entirely. A firm, bright red, easily bleeding, granulating surface that has but a slight mucus-like discharge and is free from surrounding induration or inflammation possesses a high potentiality for healing, and such granulations can usually be obtained by the simple plan of rest and frequently changed moist dressings as already described. Thin or moderately thick skin grafts have a distinct tendency to grow when put on such a granulating surface, but they will do much better if the granulations are sliced (not scraped) down to the underlying yellow scar base and the whole area is covered with large grafts put on with proper tension and pressure (Fig. 3). If it is desired to use full thickness grafts it may be safer to cover the raw surface first with thinner grafts and to apply the full thickness grafts after the

A. B. C.

Fig. 11. Contracted eye socket; grafted. A. Girl of 21 years. The eye was removed 6 years previously for some sort of tumor or possibly a severe trachoma. The socket is so contracted that an artificial eye cannot be gotten in. B. Six weeks after the orbit was grafted with split grafts put in place over two wax forms; artificial eye in place and easily removed and introduced by the patient. C. The two wax forms that were put in the orbit carrying the split grafts for the lining. They were removed on the fifth post-operative day. Patient referred by Dr. L. T. Post.

area is healed. In an indolent ulcer or an old granulating surface, all but the deepest layers of the mature scar base can be excised to advantage and either a graft applied immediately or a new, more healthy crop of granulations raised (Fig. 4).

The selection of the source, the cutting, the application, and the dressing of the graft and of the area furnishing the graft are all of importance and each should receive careful attention.

Source of the graft. The skin from which the graft is taken should be free from inflammation and it should be remembered that a graft of the thickness under consideration is apt to raise hair if it is taken from a hair bearing area. Such a development may be objectionable especially for grafts put in the mouth. We have not a few patients who have to cut hair from these grafts. This surgery usually contemplates the improvement in appearance as well as in function; therefore, visible mutilations should be avoided if possible especially in girls and girl babies. Today the areas of skin ordinarily exposed are somewhat less restricted than formerly and this is especially true in athletes, so that now the areas left from which grafts may be taken are the inner and outer surfaces of the upper half or two-thirds of the thigh, the lateral surface of the buttock, and the front of the abdomen. In babies still in diapers the abdomen is the site of choice. (Fig. 5.)

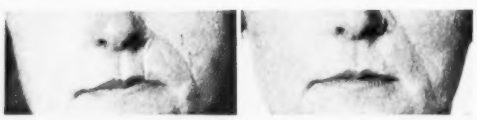


Fig. 12. Release of intra-oral scar by thick split graft. A, left. The lip is pulled up more by scarring in buccal fornix than by the external scar; the nasolabial sulcus is obliterated. B. Restoration of lip to normal length by excision of the external scar and release from the fornix scarring with a medium thick graft sewed in place over a wax form in the fornix. The nasolabial sulcus has been restored being deeply released and the resultant raw surfaces covered with a graft over a fold of gauze. Patient referred by Dr. G. J. Mautz.

The cutting of the graft. When possible the graft is cut large enough to cover the area and to extend beyond its edges. Even if it requires more than one graft it is desirable to have as few as possible and to have them of even thickness. On a large thigh with a fair amount of subcutaneous fat, especially in women, good sized grafts of fairly even thickness can be cut with a long light razor-ground knife, the skin being held tense and flat by traction pressure of small straight-edged pans above and below the knife (Fig. 6). In thin muscular men, in thin patients with flabby muscles, and on the abdomen, especially of babies, pressure methods to tighten the skin are not satisfactory. In such patients a suction retractor is almost necessary to secure the type of graft that is desired. It is helpful in any case (Figs. 7 and 8).

Fig. 13. Lip ectropion due to burn scar, released and grafted. A, left. Boy of 16 years was burned at 2½ years, with resultant ectropion of lower lip and scarring about face. The scar was released and a very large thick split graft put in place over a wax form. B. The result 20 months later. Note the straightened corner of the mouth and the quite smooth surface of the graft. There had been a secondary excision of the edge along the vermilion border of the lips, but the other edges are those of original union of the graft.

Application of grafts. The grafts are applied as soon as the bed is prepared. Definable arterial or venous bleeders of any size may be caught and tied with split silk or No. 3 catgut, but this is usually not practical except in instances in which the scar has been entirely cut through or removed. In cases in which large areas are simply denuded hæmostatic pressure with gauze is maintained as the denudation progresses. When completed, the grafts are sutured in place and the surface pressure reapplied. The graft is put on to overlap the borders of the defect; if more than one graft is needed the borders of each piece overlaps its neighbor. This overlapping is possibly a prophylactic against future visible scar. The grafts are held in place, under about normal lateral tension, by continuous basting or whipping stitches of horse hair (Fig. 9). A graft that is put on under normal stretch will be clearer and less muddy looking than one that has been allowed to contract. After the graft is sutured small holes are cut through it at appropriate intervals to insure drainage of blood and serum. A retained blood clot may be a source of failure.

DRESSINGS AND POSTOPERATIVE CARE

There has been more written on the dressings and postoperative care of skin grafts than on any other phase of the subject and in most of these contributions, many of which are a bit lengthy, the factors that we have found best to promote a quick, sure "take" either are not mentioned or are not recommended. These factors are (1) absence of virulent infection, (2) fixation, (3) pressure, and (4) provision for drainage.

Fixation and pressure can be obtained with any good, ordinary, well applied surgical dressing. Early slipping of the dressing may dislodge the graft. This is one reason why we suture the graft and why we are liberal in our use of adhesive plaster on the dressing. Any little secretion drying at the edge of the graft may block drainage or cause a dry dressing to stick and thus possibly detach the graft when the dressing is removed. Therefore, two layers of vaselined gauze are applied next to the graft under the pad and,

Fig. 14. Dressing of donor area. Diagram of cross section of leg to show dressing of an area from which a graft has been removed. Note that the greased and the dry gauze barely lap over the edge of the defect and that the adhesive comes right up to the defect. This is important to insure the stability of the dressing necessary for comfort. This part of the dressing is not changed for 9 days unless necessary. Over this dressing a larger absorbent one is placed and can be changed as often as desired. *A*, adhesive. *G*, gauze pad. *X*, six layers of xeroform vaseline gauze. *S*, uncut skin. *D*, raw surface.

Fig. 15. Deep burn, grafted in the fifth week. This patient was overturned in a farm tractor and the exhaust pipe pinned him down across the left flank. He remained there for an hour and three quarters. The frame of the tractor rested across the inside of the right thigh just above the knee and divided the tissues subcutaneously almost down to the femur, the skin remaining intact. When seen a few hours later, a burned mass of skin and subcutaneous fat covered the whole flank and extended down over the ilium. A débridement was begun but because the exact plane of demarcation was not evident and because it would probably be necessary to expose a good deal of the ilium the process was carried out over the upper half only. The burn was approximately 4 centimeters thick. Mildly antiseptic packs were used. The sloughs were soon free, and healthy granulations were obtained in the half of the area that was not excised about as soon as in the other half. Thick grafts, some of them 4 inches wide, were cut with the aid of the suction retractor from the left thigh and were sewed in place after the granulations were cut away down to a scar base. A small area of bare bone remained on the iliac crest. The grafts were applied to within one-half inch of bare bone in spite of a slight discharge as well as over the whole wound. The photograph shows the full take of the grafts even down to the exposed edge of the bone. Healing was complete in 14 days except over the exposed bone. No attempt was made to dislodge the dead bone, and the patient was sent home to wait for spontaneous separation or possibly complete healing over it. This illustrates an economical advantage in the early grafting of burns. In 5 weeks after the accident the whole area was grafted and as far as the grafts were concerned he could have gone to work 3 weeks later, but in spite of the wound mentioned he was doing work as an overseer in one month. Though 4 to 5 centimeters of tissue was burned restoration was satisfactorily made with thick split grafts. In this instance the thickness of the tissue destroyed happened to be fat deposit.

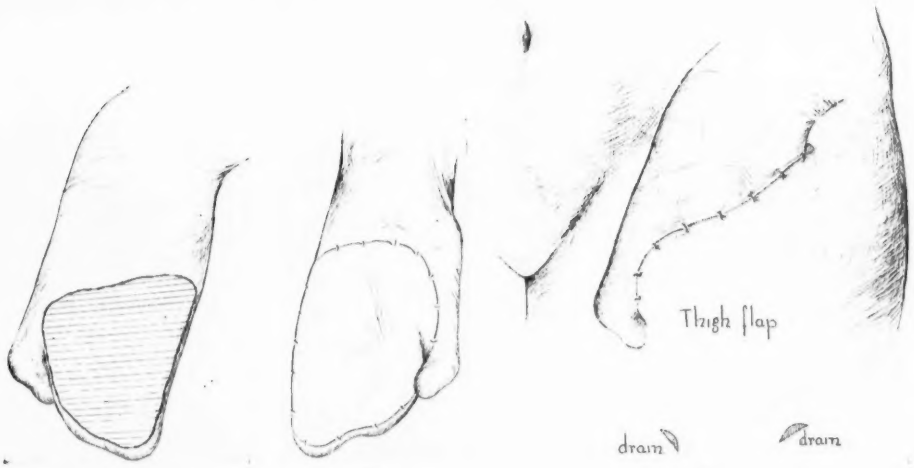
A. B.

C.

D.

Fig. 16. Electric burn scars, relaxation by decortication, grafted. A. Man aged 31 years was admitted to the hospital 5 months after he had suffered a severe electrical shock and burn. Healing had occurred, but a very thick (1.5 cm.) keratosis in the inguinal region had formed. The contraction pulled the scrotum over toward the groin; the tissues all around the area were drawn and uncomfortable. The arm was covered with thin epithelium that broke open on the slightest injury. The hand and forearm movements were handicapped. The use of a flap or of a full thickness graft of adequate size would have been but shifting the location of the defect, and also time consuming. B. The groin 9 weeks later. Note that the scrotum is free, also the comparative size of the scar area and the grafted area. The patient volunteered the statement that the grafted area was practically the same size as the original burned area. Complete subjective relief was obtained. On account of a thrombosis in the opposite leg that occurred during the healing of the burns the patient did not go back to work as an electrical lineman until 4 months after the operation, though as far as the grafted area was concerned he could have gone to work in a month. C-D. Arm grafted at the same time as operation on groin; total operative time 1 hour, 55 minutes. Excellent example of extensive repair that may be made at one sitting by utilizing this type of graft. Patient referred by Dr. F. D. Sultzman.

because xeroform is supposed to be antagonistic to staphylococci which are present in all skin and all grafts, we make up the vaseline with 3 per cent xeroform. On a firm, even surface where pressure is easily applied, such as the forehead, we may use only dry gauze sponges next to the greased gauze. On uneven surfaces, on surfaces that lack a firm foundation, such as the front of the neck, or on the hand, large, flat, damp, marine sponges, which do not touch the bare skin, are applied evenly over the gauze pads. The whole dressing is fixed by a



A. B. C.

Fig. 17. Grafting of the thigh defect simultaneous with the planting of the hand in the skin pocket. A. Clubbing of hand following burn. The dorsal surface has been freed of scar preparatory to planting it in a thigh pocket for obtaining a suitable covering. B. Thick split graft sewed, raw surface out, on the palm of the hand. When the hand carrying the thigh flap on its dorsal surface is removed, this split graft will be found attached to the thigh. C. Diagram of hand in thigh pocket. D. Fair "take" of the graft, at least enough to make complete closure of the defect possible. This split graft thus applied to fresh clean raw surfaces, except on such firm surfaces as the dorsum of the hand, forehead, etc., does not give as high a percentage of "takes" as when applied to the scar base of a decorticated granulated or healed scar surface. Nevertheless the plan is useful.

pressure bandage. In our original studies on the application of pressure dressings to skin grafts, the use of sponge rubber, inflated toy balloons, lambs wool, and damp marine sponges were included. In our experience we have found that the moist marine sponge has been the most practical distributor of pressure (1-2).

On a well prepared, healthy surface, the first dressing should be the last, but it is just as well to examine the wound at the end of 4 or 5 days, or earlier, if one has any doubt as to the healing quality of the grafted base. In some instances the dressing is allowed to remain 10 days before it is disturbed. Should a clot be found, the overlying graft is split with a sharp knife or scissors and the clots pealed out; then, if the graft is clean, there is fair probability that it will reunite to the base. Should there be an accumulation of serous secretion, yellow or clear, the detached part of the graft is cut away with sharp scissors and the area is considered not clean and is dressed accordingly. In such cases treatment consists in the application of an absorbent dressing very similar to the one used in the preparation of the granulation bed, at least daily inspection of the area,

Fig. 17D.

and the removal with sharp, fine, curved scissors of all raised edges of graft. If, after a day or two, it is found that there is still a tendency for fluid to collect under the graft or to undermine the edges, then the graft, still considered unclean, is protected by narrow three-eighths or one-half inch wide adhesive strips which span the area and adhere to the skin beyond on each side. These are placed one-sixteenth inch apart to provide for drainage. Over

Fig. 18. Combination of full thickness and thick split graft. A, left. Boy 17 years of age 2½ years after being burned, and after having received some X-ray or radium treatment elsewhere for the scarring. There is loss of the normal contour of the neck and ectropion on one side of the lower lip. B. Restoration of lip contour 2 weeks after operation with a thick split graft sutured to the surface of the chin and cheek and one applied over a curved wax form on the defect of the lip. The neck scar has been dissected out and the defect covered with a full thickness graft. Patient referred by Drs. Bierning, Lynch, and Rice.

A. B. C.

Fig. 19. Burn scar, frost bite, local tuberculosis. A. Scar over whole face from a burn 19 years before. Frostbite of the area 10 years later had resulted in further trouble with pain, ulceration, and ectropion. There is a complete ectropion of the left lower lid and a shortening of the upper. The ear is adherent to the skull. Microscopic examination confirmed the diagnosis of tuberculosis of the skin. B. Almost total restoration of the surface of the cheek, outer surface of the ear, and mastoid region, with one large thick split graft. The lower lid ectropion has also been relieved with a similar graft put it over a wax form. Note that the large graft has a wrinkled appearance due to a slight contraction of the bed scar, but this later relaxes (see C). Following the restoration of the cheek and eyelid the patient worked through the winter out of doors in comfort for the first time since the burn. C. Eleven months later, shortly after new grafts had been put on the nose, outlined with mercurochrome, upper lid, and over the orbital ridge. The ear has been released from the scalp by a graft put behind it over a form. The large cheek graft has lost its wrinkled appearance and is perfectly smooth except at the anterior edges. It has become deeply pigmented.

Fig. 20. "Portwine stain,"[1] radiation, subsequent scarring. A, left. Girl aged 9 years, with scar of radium burn following treatment for an angioma at 6 months of age. The surface was excised down to a very thin smooth scar base, going into the underlying fat in one place. One large fairly thick split graft was taken from the upper part of the thigh with the aid of the suction retractor, sewed in place, and dressed with sponge pressure. B. The full take and complete healing 18 days after the operation.

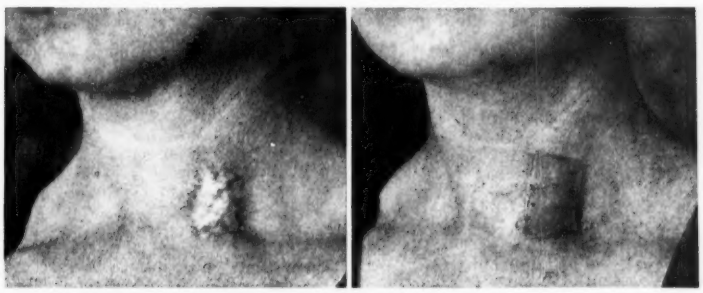


Fig. 21. Scar following radium treatment, grafted. A, left. Woman of 26 years with telangiectasis of 10 years' duration following radium treatment for goiter. There was apparently not much activity but the scar was unsightly. The area was excised and a graft put on. B. The graft 8 days after operation.

this is placed the damp drainage dressing. The latter is changed sufficiently often but the adhesive strips, which prevent trauma to the grafts, are left unchanged as long as a week if they do not become loose. Fortunately, special treatments of this kind are rarely necessary.

In certain sites such as within the mouth, on the eyelid, and on the lip, it is not practicable to obtain pressure by ordinary dressings. In these situations, if the graft is wrapped around a wax form, raw surface out, lateral tension of the graft is obtained by the friction of the graft on the wax or by the suturing under tension of the graft over the wax. In turn the tissues to be grafted are sutured under tension around the graft covered form which furnishes the desired pressure.[2] Such grafts properly implanted in a newly made wound in the mouth will, if the patient is in fair condition and not subject to any acute infection, heal in close to 100 per cent of the cases in spite of the fact that the graft and the wound have been bathed in saliva (3). (Figs 10–11–12–13.)

On two occasions the wax form of an eyelid graft was removed on the second day on account of discomfort in the eye—a complaint which should never be disregarded. The graft was lost in neither of these cases. After removal of the form the grafts are treated by the simple application of a thick layer of vaseline, which will prevent formation of crusts at the newly healed borders—another form of drainage.

[1] Portwine stains are taken care of by excision of the surface, which does necessarily penetrate the full depth of the involvement and then the application of large split grafts. Specific instances are omitted here because a separate paper on this subject is in preparation.

[2] The names of Esser, Gillies, and Waldron are associated with the war-time development of this plan of applying the graft.

A. B. C. D.

Fig. 22. X-ray burn scars, keratoses, carcinoma. A. The hand of a physician, an early worker with X-ray. The two fingers had already been amputated because of extreme change and at the base of the thumb definite low grade squamous cell carcinoma had developed. Amputation above the wrist was advised but because of the necessity of some part of a hand for his work, another plan of treatment was followed. Half of the hand was amputated, the cover was removed from the dorsum of the two remaining fingers, and an abdominal flap was put in place. B. The hand 30 months after the rest of the covering has been removed and replaced by a thick split graft. The free graft limits are within the dotted lines. C. The other hand 1 week after a number of its keratotic areas had been excised at one operation and replaced with these grafts. D. The same hand 20 months later and the smoothing out of the grafts, that occurred without further operation. Patient referred by Dr. C. S. Venable.

Fig. 23.

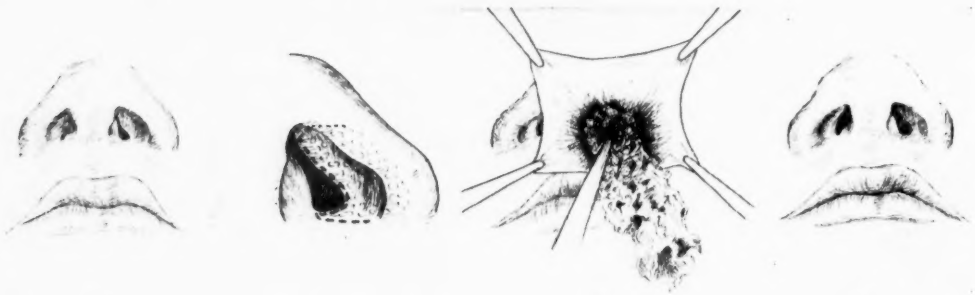
Fig. 23. Old roentgen-ray burns excised, grafted. Woman of about 55 years treated with X-ray 14 years ago for fibroids. The skin looked red and leathery for 8 years. Ulcerations then occurred and were present for 6 years. She was treated with Quartz light and during this treatment became worse. Examination showed involvement from just above the pubis almost to the umbilicus, 12 to 15 centimeters wide on each side. There was telangiectasis, scarring, keratosis, and ulceration. At operation a wide deep excision was done. There were places where the aponeurosis couldn't be identified, and there was a question whether malignant change had taken place. (Malignancy was not found on microscopic examination.) The resultant raw surface was not a real satisfactory surface for any kind of free graft and while it was appreciated that grafts applied might not all grow, with this type of graft there is little lost in trying. Two large grafts were cut with the aid of the suction retractor, sewed in place, and firmly dressed with sponge pressure. The largest of these grafts was 25 centimeters long, 15 centimeters wide on one end and 10 centimeters on the other after they were on the abdomen. There was about 50 per cent loss of these grafts. Seven weeks later at the time of a second operation the raw area had contracted so that the defect was about one-fourth the size of the original. Split grafts were put in place in three sections after cutting off the granulations. Healing was complete in 2 weeks. The patient is shown here 3 months after the second operation. She is free of subjective sensations and no ulceration or other signs of activity are present. Patient referred by Dr. E. Jonas.

A. B. C.

Fig. 24. Primary skin cancer complicated by radium burn. Ulcer had persisted 15 months. Flexion of the wrist and fingers was limited by the contraction. The ulcer, including the whole scarred area, was excised down to the deep fascia, which apparently was not involved, and immediately grafted. B. Roughening of the area that occurred in the first few months after grafting. C. Result 16 months later with full flexion possible and 100 per cent function. Note that the graft has stretched and that the junction with the surrounding skin can hardly be made out.

A. B. C.

Fig. 25. Restoration of covering of dorsum of hand. A dentist aged 41 years lost most of the skin of the dorsum of the hand in an automobile accident. The tendons were exposed and torn but none was severed completely. When admitted to the hospital, the wound was covered with clean granulations, and movement was hindered considerably. In this instance the granulations were cut off down to a yellow scar base and two thick split grafts were used to cover the defect. The grafts were put on as a surgical dressing to get the wound clean enough so that a thicker pad, either a full thickness graft or a flap, could be transplanted. A. The graft 4 months after the operation. Function was good and the patient was able to attend to his dental practice with so little inconvenience that he did not return for further work. B and C show the hand after about 2 years. Note the normal looking wrinkling of the skin. The wrist cannot be fully flexed because of tightness of the extensor tendons and not because of lack of skin covering. Patient referred by Dr. C. H. Jameson.



A. B. C. D.

Fig. 26. Restoration of nasal passage after almost complete atresia from scar contraction in the vestibule. A. Original condition of left nostril which is obstructed by a scar contraction at the junction of the vestibule with the nasal cavity. B. Incision along the border of the impinging fold of the vestibule lining continued across the floor of the vestibule to the border of the ala (indicated by the heavy dashed line). The transverse line of light dashes above indicates a part of this incision that is hidden within the nostril. The outlined trap-door is dissected forward with its base toward the alar border, and from behind it is removed enough scar and fibrous tissue to give a very much expanded vestibule. The stippling indicates the extent of the excavating. The trap-door is dropped back into place, and a large split graft is put in in the form of a Mikulicz pack with a strip of moistened fine "silk" marine sponge as the core. The pack is kept from slipping by one horse hair suture from the ala to the columella. D. Diagram of final result in a case so treated. The nostril has remained open and functioning for 5 years. In lining a contractile cavity with a split graft allowance should always be made for contraction.

The graft and the conjunctival sac should receive daily attention. Great care should be exercised in the removal of the wax forms. With a sharp knife or scissors, a cut should be made carefully through all stitches and the excess graft overlying the outer surface of the form, and this process continued until the form itself can be plainly seen. Then separation to each side is carefully accomplished, and with the aid of soaking if necessary the form may be loosened from the graft and lifted from its bed. The dead edges of the graft can then be trimmed and the cut sutures removed.

Dressing of the donor area. Discomfort in the area from which the graft has been taken may be caused by one of two factors: (1) infection which might rarely occur from organisms liberated from sweat and sebaceous glands at the time the graft is cut; (2) movement or pulling of the dressing. Ordinarily these areas are made comfortable by immediately applying six smooth, flat layers of vaseline xeroform gauze covered with a flat gauze pad, neither the gauze pad nor the greased gauze extending more than ¼ inch beyond the raw area. The whole is then firmly strapped in place by means of adhesive plaster which prevents any sliding or pulling on the raw surface of this deep dressing (Fig. 14). Over this is bandaged a protective absorbent pad which may be changed as it becomes soiled. If two parallel grafts are taken from the thigh, a strip of uncut skin is left between the defects for the attachment of adhesive plaster. Ordinarily, at the end of 9 days, the blood soaked original dressing is lifted off or it is soaked loose by a wet pack. If the graft has not been cut too deep, the whole area is usually found to be healed. If in any place the cutting has gone down to the fat, healing at such spots will be delayed. If the patient walks about at this time it is well to reapply a firm pressure dressing under adhesive plaster to try to prevent the possible formation of small hæmatomata under the fresh thin epithelium. If it becomes uncomfortable before the ninth day, the dressing is soaked loose, and the area redressed with the greased gauze. If infection occurs, damp pressure dressings are used.

Fig. 27. Total restoration of the skin of the forehead. The forehead tissue was used for a lip reconstruction and the forehead covered with a single large thick split graft put right on the periosteum. Note that the graft edge has come to the same level as the skin of the scalp. The graft has also become quite movable. Patient referred by Dr. A. B. Kanavel.

TREATMENT OF DEEP BURNS

Willis (4) and others have treated burns by immediate excision down to the sound tissue and then grafting the raw area, if necessary, when the wound has become sufficiently clean. In cases in

which this can be successfully accomplished it is of real advantage. Regardless of the will to do so, in many cases whether from the extent of the burn, the condition of the patient, or the controlling circumstances, such treatment is at present impracticable. This should not, however, make one content with a practice all too prevalent of allowing these wounds to become deeply infected and to granulate and suppurate for months and possibly years before the wounds are covered with hard, distorting, limiting scars which, without later help, cripple the victim throughout life and later are too often the site of cancer. Figs. 4–15–16–17–17–19.) Most joints so fixed by scar can be released by means of flaps or full thickness grafts. This is not true, however, of the fingers which, during the slow healing process of a burn extending little deeper than the skin, often become so fixed by periarticular thickening that a year or more of manipulation may be necessary to release them or they may never become released.

Immediately after the calamity of an extensive burn, relief of pain and preservation of life are the all-embracing considerations; but, as early as possible, means should be taken to protect the wounds from infection and to encourage drainage. The so-called open treatment of burns, which too often means a pus poultice under crusts, may be sufficient for superficial burns, but our observation of the late results of such treatment of deep burns makes us feel strongly that whenever possible some other plan of treatment should be instituted especially when the full thickness of the derma is destroyed. When we have treated fresh burns we have usually been able to secure a healthy, firm, granulating surface within a month, and have the grafts healed in place within 2 weeks more (Fig. 15).

We have the most profound respect for the skill and devotion of the man who brings one of these badly burned children through alive, and we see many on whom the scarred area is so extensive that it probably would not have been practicable to have covered the early wound completely with grafts. Here the judicious use of the small deep graft as described by Davis should greatly shorten the convalescence and might be all that would be necessary. In spite of many literary citations to the contrary, all our experiments with homo-grafts have ended in the graft being completely absorbed in from 3 to 6 weeks after it had healed in place, even when the bloods matched. Our observations, however, are incomplete as we have never tried the application of grafts from one young child to another of similar age nor have we grafted from one identical twin to another.

Roentgen-ray and radium burns (5). In the treatment of radium and roentgen-ray burns, the object should be the complete removal of the involved tissue, with an attempt to get beyond the limits of the endarteritis, the telangiectasis, and of the active keratosis. Upon the type or degree of burn present, the size and depth of the necessary excision, and the location of the defect on the body, will rest the choice of method of repair. If free skin grafting seems indicated, full thickness grafts or thick split grafts may be used.

In those burns evidenced by change in color, by telangiectasis, and possibly by some slight scaliness, the preparation of the bed for the graft may be done, as in healed burn scars, by slicing off the surface down to a very thin layer of derma and then immediately grafting with thick split grafts. If, in these areas, there are any smaller areas of excessive scaliness or keratosis, the excision should go deep and the defect in the graft bed should be closed with sutures to try to preserve smoothness if it is desired. Though trouble might possibly develop later in these areas, so far we have not had any. If it should occur deeper excision and regrafting should be done (Figs. 20–21).

Burns in which active keratosis is present should be widely excised to their full depth, though the determination of their extent may be difficult. If free grafting is indicated, the thick split graft will be appropriate in many instances (Figs. 22–23.)

LARGE FACE AND NECK BLEMISHES

We have treated large areas of damage to the skin of the face and neck, especially in women, such as oil or dirt filled superficial abrasions, large nævi or hairy moles, and scars resulting from trauma, acid or radiation, by dissecting off the lesion or scar down to the subcutaneous tissue and then, after allowing the area to granulate for 3 weeks, applying a thick split graft, as described under burns. If the scar is in the form of plaques, in or under the derma, as has occurred from long severe acne or smallpox, great improvement has resulted from dissecting off the damaged skin and the bases of the pits and applying the graft to a deeper plane of this blanket scar.

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PALINGENESIS OF VISCERA[1]

J. CHRISTOPHER O'DAY, M.D., F.A.C.S., HONOLULU, HAWAII

WHEN that closely observing French physician, Glénard, gave to the medical world the treatise on gastro-enteroptosis that immortalized his name, it was with no thought that the disease would ever become a surgical one. "For successful treatment," he says, "the following must be carried out: (1) the intestines must be raised and maintained in their position; (2) the abdominal tension must be increased; (3) the bowels must be regulated; (4) the secretions of the digestive tract and of the annexed glands must be stimulated; (5) the alimentation must be regulated and the digestion assisted; and (6) the organism must be stimulated."

Speaking of Glénard's work in relation to gastroptosis and enteroptosis, Einhorn has this to say: "The idea which led the French physician to the discovery of the disease designated by his name (Glénard's disease) was the fact that the whole digestive tract, which from the mouth to the anus is ten or fifteen times longer than a straight line connecting both points, is arranged in the form of different baldachins suspended on six loops by means of ligaments at the posterior wall of the abdomen. . . . The zigzag direction of the loops offers the possibility of too great a bend, sometimes at such an acute angle that it causes obstruction to the passage of the ingesta or secretions at the six main points of fixation."

The light the years intervening between Glénard's time and now have thrown on this subject has not changed one of those six main points.

Ptosis of the abdominal viscera which has progressed to a degree capable of producing kinks of occlusion, particularly in the duodenum, will cause discomforts that may be difficult to differentiate from those caused by peptic ulcer or gall-bladder disease. On the other hand, similar occlusions at the lower ileum or cæcum may, in effect, simulate any one of the various appendiceal disturbances. This is a point that will bear emphasizing, for it is true that many an able and conservative abdominal surgeon has been tricked into performing gastrojejunostomies or appendectomies that, failing to give the expected relief, have made a repentant of one who unwittingly neglected to consider the likelihood of the presence of a gastro-enteroptosis. Indeed, we must not forget that gastro-enteroptosis is a characteristic affliction in a certain type of individual. Moynihan says, "The patient is almost always a neurasthenic of a most pronounced type."

This statement is true as far as it goes; the danger lies in the inference that the neurasthenia is the cause of the ptosis. In my opinion, judging from the work of Coffey and from my own experiences, many cases of extreme visceroptosis give rise to that syndrome of complaints which, out of a better understanding, we classify as neurasthenia, and yet, once a correction of gastro-intestinal function has been accomplished and the neurasthenic no longer complains, our belief in the neurasthenic cause of ptosis becomes less secure. In fact, we cannot ignore the numbers of neurasthenics who have no digestive disturbance at all. It is best not to try to associate a purely mechanical disease with any temperamental type of individual. But there is a type we must not ignore if we wish to be on the alert; ptosis of the abdominal viscera belongs only to the slim Jims.

The first requisite of Glénard's treatment was to raise the intestines and then maintain them in the raised position. To accomplish this he used a pad. The pad was worn in such a manner that pressure was exerted on the lower abdomen. Nowhere is he enthusiastic about the ultimate results of this treatment. The principle is correct. Correction, however, can be properly accomplished only by careful surgery. Without it palingenesis of visceroptosis is impossible.

When the abdomen has been opened in the belief that peptic ulcer, gall-bladder or appendiceal disease will be encountered and we find no such condition, the sting of our humiliation will be lessened if due regard has been given to the type and the likelihood of existing prolapse. With a well-defined set of plans that can be relied on to determine and correct an existing visceroptosis we may proceed with the operation without the betrayal of that awkwardness inevitable in single tracked attitudes.

Before an intelligent or clear conception of gastro-enteroptosis can be derived, it will be necessary to have become familiar with the embryological development of the peritoneum. We learn, then, how the duodenum became fixed in a peritoneal tunnel that has its termination to the left of the vertebra and from which it emerges to join the freely mobile jejunum.

The stomach may occupy a position much lower than that which we have been wont to

[1] Read before the Oregon State Medical Society, LeGrande, Oregon, May 16–18, 1929.

regard as normal and not cause distress. However, if it is low enough to interfere with its own motility where should we look for the evidence of that interference? At the entrance of the tunnel. There the drag of the prolapsed stomach has produced a kink, and we find a dilated proximal stomach and a collapsed distal duodenum. The gastrohepatic ligament is no longer capable of supporting the stomach.

Let us assume that instead of observing a dilated stomach in association with an occlusion of the upper duodenum we find that both stomach and duodenum have undergone a marked dilatation. Where, then, should we look for the obstructing kink? Picking up the jejunum just distal to the duodenojejunal junction and finding it normally patent we are warranted in concluding that the occlusion is caused either by a tightening of the superior mesenteric vessels in their transit over the lower portion of the duodenum or else by a kinking at the margin of the outlet of the tunnel—the latter being of most infrequent occurrence.

The mesenteric root crosses the vertebra from upper left to lower right. If it is given a downward pull, by reason of this position, it falls toward the left flank. When we find the mesenteric root in the left flank, a survey of its fat is taken. If there is a goodly leaf of fat between its folds, we have the assurance that the lacteals are imposing no hindrance on the free passage of the chyle to the thoracic duct. On the other hand, should it have lost its fat and come to resemble tissue paper with blood vessels sprawling over its threatening thinness, the conclusion is justifiable that such a degree of starvation could not obtain under any conditions other than partial occlusion of the lacteals themselves.

With hepatic and splenic flexures intact, ptosis of the transverse colon cannot reach a degree extreme enough to produce any symptoms whatsoever. The point to be determined relates to the two interdependent ligaments: i.e., the gastrohepatic and the gastrocolic. When for the need of the support of the gastrohepatic ligament the stomach has gone down with the transverse colon, the drop, if low enough, can kink the duodenum at the entrance of its tunnel.

It should be kept in mind that unless the gastrohepatic ligament becomes inadequate, kinking at the entrance of the tunnel cannot obtain. And further, it must be remembered that the gastrohepatic ligament, whether adequate or inadequate, has no part in the production of occlusions of the lower duodenum. Such obstructions can come only from a drag on the mesenteric

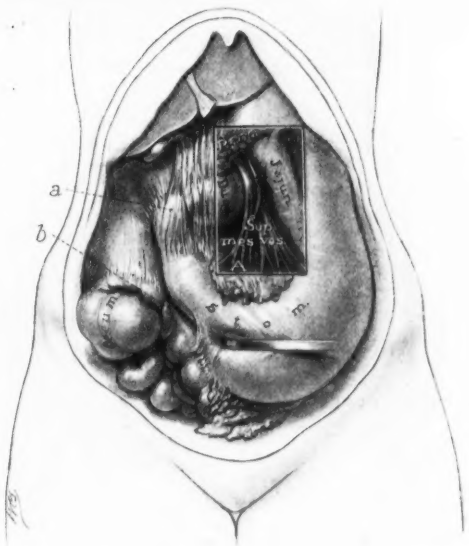

Fig. 1. *a*, Drag and kinking on upper portion of duodeum; *b*, ptosis of ascending colon producing twist at ileocæcal junction. Insert *A* shows the superior mesenteric vessels as they emerge from pancreas to cross over lower portion of duodenum.

root which either obstructs by kinking at the jejunal beginning or else by tightening the superior mesenteric vessels over the last portion of the duodenum. These obstructions can be relieved only by a posterior, no-loop gastrojejunostomy.

Ptosis of the transverse colon alone, meaning that the gastrocolic ligament has become overstretched between stomach and colon, need not be regarded seriously. But when the ascending colon and cæcum are mobile and the ascending colon has gone down with its transverse fellow, inspection of the ileocæcal junction will reveal a twist that not only inhibits passage into the colon but diverts the stream so directly into the cæcal pouch that dilatation, made worse by stasis, converts the caput coli into a very mischievous cesspool.

There is another sequela of visceroptosis not to be overlooked—interference with the return of the venous blood—which is recognized by either a general or local cyanosis. Viscerocyanosis associated with lower duodenal occlusion bespeaks the extent to which the drag has impinged upon the superior mesenteric vein. In cases in which the cyanosis creates a zone immediate to the

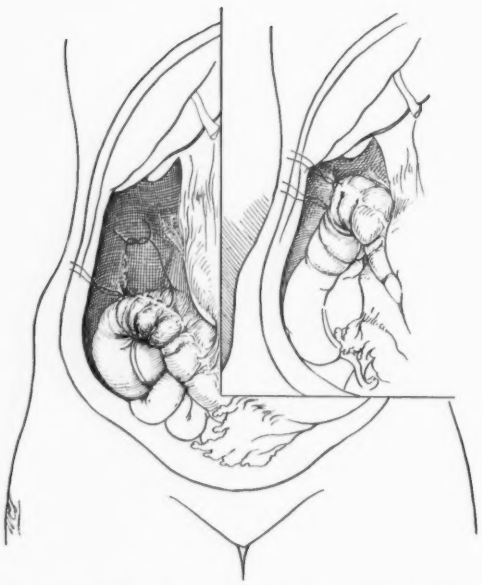

Fig. 2. Suture of ascending colon to posterior parietal peritoneum.

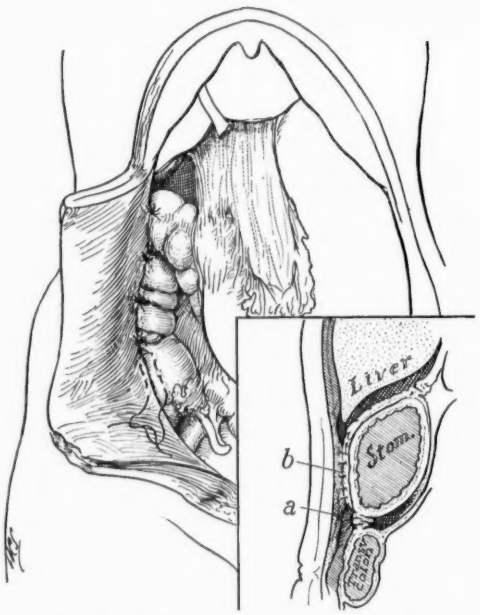

Fig. 3. Suture of ascending colon to lateral parietal peritoneum. *a*, Plication of gastrocolic ligament; *b*, anterior and lower portion of stomach sutured to falciform ligament and reflection of peritoneum.

point of occlusion, it can be readily recalled that undue pain and tenderness were pre-operative indications.

In one of my earlier articles[1] I made a distinction between ptosis, stasis, and inertia. The distinction should not have included stasis beyond that it is a mere symptom that belongs to each of the other two conditions.

It is when we subject this symptom as it is related to these two visceral inhibitions to a careful scrutiny that it immediately becomes apparent how the two may be confused. But the treatment of each being so diametrically opposed, neglect of differentiating can ill afford to be countenanced. Ptosis is a mechanical interference of function; inertia is a paralytic interference of the same function. Ptosis exerts its baneful effect by causing partial strangulations at given points. Its treatment is, therefore, mechanical.

When the venous circulation becomes involved it would not be unreasonable to assume that the portal function of the liver becomes, to a degree, somewhat affected. This, of course, is conjectural, yet the subnormal temperature so frequently observed accompanying the condition would suggest such a possibility.

With inertia no points of kinking or constriction are to be found, the stasis is general, the transit of bowel content is slow in consequence of a sluggish peristalsis. Obviously pain cannot be considered in the presence of inertia.

With ptosis there will be not only cramp-like and colic-like pains but as well a point of tenderness over each stenosed portion of the gut. We must remember that precisely the same principle holds good as in making a differential diagnosis between gastric atony and pyloric occlusion. In both of these inhibitions the contents of the stomach are long retained, but in atony there is no pain. The stomach is inert. With pyloric occlusion, the stomach still possesses its motive power and each contraction produces a pain commensurate with whatever degree of pyloric narrowing has obtained.

Another point to be emphasized is the uncertainty of roentgenograms. Indeed, no roentgenogram can be properly interpreted unless the type of the individual is first considered, for all long waisted, flat bellied people give pictures

[1] The interrelation of stasis, ptosis, and inertia of the intestinal tract. Ann. Surg., 1918, July.

that greatly resemble ptosis whether or not stasis exists. Again, the picture reveals those peculiar separations and accumulations of barium so easily mistaken for occlusions that unless the importance of pain, as the paramount means of differentiating, be included, grave doubts and uncertainties may befog what should really have been a clear and concise diagnosis.

Let me qualify this last statement. By a clear and concise diagnosis I do not mean that diagnosis should be absolute but rather that a conclusion be reached wherein we are assured that surgery is imperative. Then, when the abdomen is opened, we may be saved the humiliation of having made a useless incision.

In the absence of pathological conditions in the stomach, duodenum, gall bladder, or appendix it will be forcibly brought to mind that the undue droopings of the viscera as noted in the roentgenograms have carried these organs far enough beyond the range of their natural supports to have produced the acute angles necessary to cause occlusion.

At this juncture we must seek the vulnerable points. Beginning with the gastrohepatic ligament direct inspection of this support is not necessary. Instead, traction is made on the stomach and held to the limit of the downward pull until it is ascertained whether the check comes on the duodenum. If it does, the kinking over the margin of the duodenal tunnel is immediately brought into view. Beginning thus the inspection is most aptly carried out in the following order: adequacy of gastrohepatic ligament by traction on stomach; upper and lower duodenum; duodenojejunal junction—gastrocolic ligament; root of mesentery; mobility of ascending colon and cæcum.

While there comes an assurance to reward one for the making of this survey, it is well to have in mind the disaster that is so very likely to follow any attempt to deal directly with constricted or flattened out blood vessels (veins). If the viscera are rehabilitated to whatever degree their environments will permit, the veins will take care of themselves.

Enteroptosis is too frequently associated with gastroptosis to permit the correcting of one without having ascertained the possible presence of the other. This is a phase of visceroptosis that textbooks have failed to emphasize. Indeed, gastroptosis should never be considered separately. So seldom is it the sole trouble that no matter whether the operation of Coffey, Duret, Rovsing, or Beyea has been employed no good will come of it.

There is another thing well worth having in mind. It is this, *ptosis that produces occlusion of the lower duodenum by traction on the superior mesenteric vessels is a ptosis that had its origin in a congenitally made movable ascending colon and cæcum.* We need but glance at a ptosed ascending colon where it has kinked over the meso-ileum to understand just how traction is ultimately transmitted to these vessels. Robert C. Coffey, in his classical treatise of enteroptosis, traces the cause of movable ascending colon and cæcum to an embryological inability of the peritoneum to become fused into the needed layers of support. Coffey's experimental work proved this to be the key to the entire problem of enteroptosis.

This is the reason I have used the word palingenesis. By means of surgery we are going to give to a set of misplaced viscera their normal positions of which they have been deprived through some trick of nature during embryological development—an artificial rebirth, as it were.

TREATMENT

The pocketing of the caput coli beneath the posterior parietal peritoneum lacks surgical appeal, nor does it seem necessary. With the appendix present, enucleation from out its serosa leaves a well selvaged meso-appendix that can be shelved into an equally secure support. It is not always possible to re-instate the ascending colon to the site originally destined for the hepatic flexure. However, when we set to work to fuse the peritoneum into those ligamentous supports that, by some trick of nature, have been deprived of their embryological rights, it must not be forgotten that immobilization of the ascending colon to a point high enough to protect the ileocæcal junction from a recurrence of the kinking is the thing that must be accomplished. It is the only means of relieving the drag on the meso-ileum which, in turn, becomes transmitted to the root of the mesentery.

To facilitate the work of immobilizing the ascending colon, its transverse fellow, the great omentum, is drawn upward and out of the peritoneal cavity. The small intestines are then induced to the left and held there by properly adjusted gauze packs. A curved intestinal needle, armed with either fine chromic gut or linen, picks up several bites (no less than three) of the posterior parietal peritoneum, passes to the colon, and takes from below upward, a similar number of seromuscular bites (Fig. 2). If these stitches are carried, interruptedly, as high as it is possible to go toward the site of the hepatic flexure, their tying will bring into apposition two

substantial peritoneal welts. The process is repeated directly opposite, the folds on the colon being sewed from above downward and gathered first to come upward on the lateral parietal peritoneum (Fig. 3). If the cæcum is markedly dilated, it should be plicated to normal dimensions and given support.

The gauze pack is removed. The transverse colon and great omentum are restored to the abdominal cavity. The gastrocolic ligament is examined. If too long, it is shortened by plication so that the transverse colon and the greater curvature of the stomach are brought together. While textbooks graphically describe methods of shortening the gastrohepatic ligament or omentum, none of them has seemed feasible because such methods are so likely to endanger blood vessels. Rather than assume such a risk we have used the falciform ligament in conjunction with a reflection of the anterior parietal peritoneum. These are so fused to the anterior lower portion of the stomach that a horizontal plane is established and maintained between the upper portion of the duodenum and the stomach.

A mobile descending colon I have yet to encounter. This fact suggested the modification of Coffey's hammock operation. Instead of attaching the great omentum across entire width of abdomen, I stop when enough hammock has been made to support well the stomach's lower third.

DISSECTIONS OF THE RECURRENT AND SUPERIOR LARYNGEAL NERVES

The Relation of the Recurrent to the Inferior Thyroid Artery and the Relation of the Superior to Abductor Paralysis

DAVID D. BERLIN, M.D., and FRANK H. LAHEY, M.D., F.A.C.S., Boston, Massachusetts

TO demonstrate in the anatomical laboratory what we had seen at the operating table, dissections of the recurrent and superior laryngeal nerves were made by Dr. Berlin. We hoped thus to determine (1) the difference in relationship between the recurrent laryngeal nerve and the inferior thyroid artery on the right and left sides and (2) the possibility that some of the fibers of the superior laryngeal nerve, other than the branch to the cricothyroid muscle, were motor in character, which would perhaps explain the fact that the vocal cords are held in close adduction at least late after severance of the recurrent laryngeal nerve. The truth of this latter statement was proved to us by the recent personal observation of a patient who was operated upon elsewhere for exophthalmic goiter and who came to us with a very definite bilateral abductor paralysis with both cords in marked adduction and with a very narrow glottic space. We operated upon this patient and found the right recurrent laryngeal nerve completely severed, thus demonstrating the fact that the vocal cord may be held in complete adduction, even after the nerve (adductor fibers of the recurrent) supposedly supplying the adductor muscles of the cord is cut.

It has been demonstrated in animals that the recurrent laryngeal nerve contains two sets of fibers, adductor and abductor, and that this nerve innervates the muscles of abduction and adduction of the vocal cords. In the case of the patient mentioned, who came to us 3 years after a thyroid operation, the cords were not relaxed in the cadaveric position following severance of the nerve (which was identified as such by laboratory examination) but were in complete adduction demonstrating the fact that they must be held there by some motor innervation other than that of the recurrent laryngeal nerve. It is interesting to record that in our patient it was demonstrated that the recurrent laryngeal nerve was completely severed, and the superior laryngeal nerve was cut at the point where it penetrated the thyrohyoid membrane, so that the possible motor innervation of the interarytenoid at least on one side was severed.

It is of further interest that following severance of the internal branch of the superior laryngeal nerve, immediate observation showed no change in the position of the cords. The laryngologist reported that the only difference that could be noted from the pre-operative observance of the cords was that the right cord was perhaps narrower than the left.

In our group of dissections there was a significant variation in the findings between right and

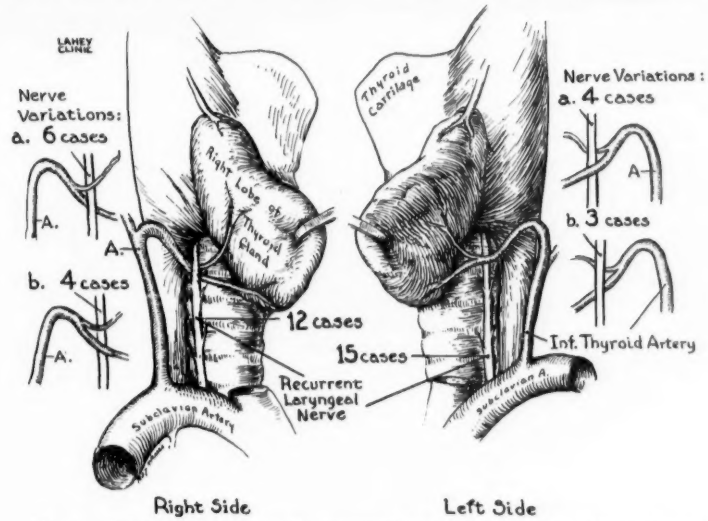

Fig. 1. Relationship between the recurrent laryngeal nerve and inferior thyroid artery with variations on both right and left sides in a series of 22 neck dissections.

left sides. The observations made were as follows:

On the right side. In 18 out of 22 dissections, the nerve was anterior to the artery, and in this group, 6 appeared anterior only to the lower larger terminal branch of the artery and posterior to the upper ascending division. In the remaining 4 dissections the artery was anterior to the nerve and in very close contact with it. (Fig. 1.)

On the left side. The artery was demonstrated anterior to the nerve in 19 dissections, and in this group, the nerve passed between the terminal branches of the artery 4 times, coursing posterior to the lower branch and anterior to the upper division of the vessel. In the remaining three dissections the nerve was anterior to the artery. (Fig. 1.)

As to the relative position of the recurrent nerves on the trachea, it was observed that they both run in the tracheo-œsophageal sulcus, with the left more often appearing a little deeper in the sulcus than the right, but it cannot be said that the right lies more anteriorly on the trachea than does the left, as stated by Dilworth.

Dr. Berlin's dissections demonstrate quite definitely the difference in relationship between the recurrent laryngeal nerve and the inferior thyroid artery on the right and on the left—something to be remembered in the ligation of the inferior thyroid artery—and the fact that a twig from the superior larnygeal nerve quite constantly supplies the interarytenoid muscle.

At the suggestion of Dr. Lahey, a series of 34 dissections were carried out to study and demonstrate 2 distinct anatomical entities.

1. Twenty-two dissections were made to show the relation between the inferior thyroid artery and the recurrent laryngeal nerve, comparison being made between both sides of the neck.

2. Twelve human larynges were dissected for the purpose of demonstrating their nerve supply, particular attention being paid to the source of innervation of the interarytenoideus muscle.

With reference to the first group of dissections, it is notable that none of the classical textbooks in anatomy describe differences in the relationship of artery and nerve between right and left sides. The following quotations are from some of the authors:

Gray: "The inferior thyroid artery divides into two branches at the lower border of the thyroid gland and the recurrent nerve passes upward generally behind the artery."

Jackson: "The relation of the recurrent nerves on the right and left sides is alike after they gain the tracheo-œsophageal sulcus."

Davis (*Applied Anatomy*): "The inferior thyroid artery is usually in front of the recurrent laryngeal nerve."

Cunningham: "The inferior thyroid artery divides into ascending and terminal branches with the recurrent nerve passing either anterior or posterior to the vessel."

Dilworth: "In 33 dissections the artery was on

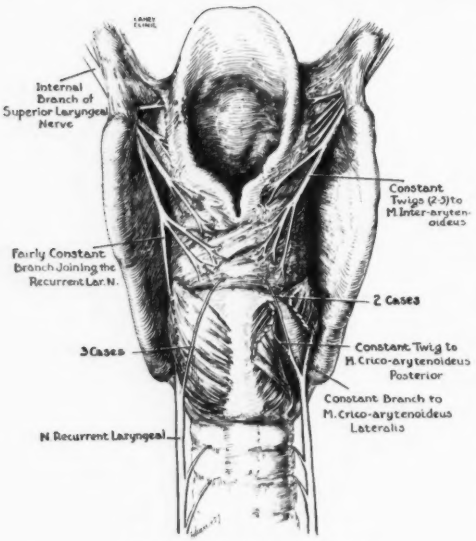
Internal Branch of Superior Laryngeal Nerve
Constant Twigs (2-3) to M. Inter-arytenoideus
Fairly Constant Branch Joining the Recurrent Lar. N.
2 Cases
3 Cases
Constant Twig to M. Crico-arytenoideus Posterior
Constant Branch to M. Crico-arytenoideus Lateralis
N. Recurrent Laryngeal
Posterior Aspect of the Larynx

Fig. 2. Posterior aspect of the larynx illustrating the nerve supply to the intrinsic muscles with especial reference to the interarytenoideus muscle.

a more anterior plane than the nerve except for its terminal branches that may be posterior to the nerve." This author also observes that the right recurrent nerve lies more anteriorly on the trachea than the left.

NERVES OF THE LARYNX

The naked eye dissections of the 12 larynges showing their intrinsic nerve supply disclosed a constant finding relative to the innervation of the interarytenoideus muscle.

It is our impression that the medical students of today are taught both in gross anatomy and in the specialized course of laryngology that the larynx receives its nerve supply from the recurrent nerve and the superior laryngeal nerves, the former being motor while the latter is sensory, with the exception of its external ramus supplying the cricothyroideus muscle. To quote from Sobotaa and McMurrich (1914) vol. iii, p. 210: "The inferior laryngeal nerve supplies all muscles of the larynx with the exception of the crocithyroideus, which is innervated by the external branch of the superior laryngeal nerve." In all of the 12 larynges, this was not found to be so. On the contrary, there was a constant group of nerve filaments (varying from two to five in number) branching out in the interarytenoideus muscle derived from the lower division of the internal laryngeal nerve. There was a constant twig also from the recurrent nerve to the crico-arytenoideus posterior (abductor of the vocal cord) passing deep to the muscle but in only 2 instances reaching the interarytenoideus muscle. In 3 cases there was a slender twig from the recurrent nerve reaching the interarytenoideus muscle running alone over the crico-arytenoideus posterior, while at the lateral margin of the latter muscle a fairly constant ascending twig joined with a similar descending twig derived from the internal laryngeal nerve (the so-called rami communicantes). A constant deeper anterior ramus supplied the crico-arytenoideus lateralis (adductor of the vocal cord) and thence passed to the thyro-arytenoideus and smaller muscles in the aryepiglottic fold.

CONCLUSIONS

The recurrent nerve tends more commonly to be anterior to the artery on the right side than on the left, while the reverse may be said of the left side.

It should be borne in mind that while the nerve may be posterior to the lower branch of the inferior thyroid artery, it may appear anterior to the upper branch.

The relations of both recurrent laryngeal nerves to the trachea are essentially alike.

The interarytenoideus muscle receives its main innervation from the internal laryngeal nerve and occasionally an additional twig from the recurrent laryngeal nerve.

GONOCOCCUS ARTHRITIS—A STUDY OF SIX HUNDRED TEN CASES

HEINRICH L. WEHRBEIN, M.D., NEW YORK
From the Urological Department, Bellevue Hospital

ARTHRITIS due to the gonococcus is a comparatively rare complication. It has been estimated that but 1 to 3 per cent of all gonococcus infections lead to the metastatic infection of one or more joints. Since gonorrhœa is more prevalent in metropolitan districts than elsewhere, in a city like New York, practitioners see a fair number of cases.

Gonococcus arthritis presents difficult problems both for the patient and for his physician. The patient suffers great pain and the disability usually lasts a comparatively long time.

Aside from the presence of the gonococcus, little or nothing is known about the various factors which are responsible for gonococcus arthritis. Constitutional factors may be responsible to some extent but this has not as yet been demonstrated. Neither has it been shown that previous non-specific joint infections predispose toward gonococcus infections of the joints. The often quoted observation, however, that a patient who has suffered from gonococcus arthritis is more likely to develop metastatic joint lesions during a subsequent gonorrhœal infection, can be proved. The frequent history of trauma has led many observers to the assumption that trauma is one of the major contributory factors. Pathological considerations, namely, the metastatic origin of joint lesions and the great frequency of multiple joint infections, make it appear that trauma cannot be anything but a minor contributory factor.

The clinical picture is fairly simple. The majority of patients present one or more joints which are swollen and painful; active and passive motions are usually impossible during the early days, and the pain may even be so great that sleep is impossible. The temperature is moderately raised and the patient may or may not have additional urological complaints, as urethral discharge, dysuria, or nocturia. No age seems to be exempt. The incubation period, that is the time elapsed between the primary infection and the metastatic joint lesion, is most indefinite. The duration of the active stage, that is the stage of great pain and acute inflammation, may vary from a few days to several weeks. The complete recovery of the infected joint may require only 1 or 2 weeks or as much as 6 to 12 months. The outcome may be a normal joint or any degree of permanent change up to bony ankylosis.

The pathological anatomy of gonococcic joint lesions is varied. The first stage is usually one of moderate serous effusion with swelling of the synovial membranes and infiltration of these membranes with plasma cells and histocytes. As the process advances, large numbers of polymorphonuclear leucocytes appear, infiltrating the synovial membrane as well as clouding the free fluid in the joint. Depending on the severity of the process, erosion of the cartilage and atrophy of the adjacent bony structures may occur. Small areas of decalcification are quite common. With the repair process, exostoses, fibrous adhesion bands, and osseous adhesions may form. The peri-articular tissues are usually involved to some extent. Simple inflammatory œdemas are most common, but even phlegmons may occur in very severe infections. The infections of bursæ and tendon sheaths are essentially the same with the exception that the bony structures are not involved. It also may be said that infections of the tendon sheaths are often of the severest type with the formation of phlegmonous swellings, abscesses, and extensive lymphangitis. The infections of the periosteum seem to incline toward the formation of exostoses. Osteomyelitis of gonococcic origin is rare but has been described (4, 16).

In order to make a simplified presentation, the various arthritis cases may be classified into groups. Many such groups have been proposed and used, but in consideration of the material about to be presented, it has been found appropriate to use the following classification:

1. Cases of arthralgia, namely, cases in which merely pain is the symptom. The physical examination of the joint, including roentgenograms, is negative. The spasticity of the muscle groups supplying the joint is of course secondary to the pain.

2. Cases of arthritis with simple swelling and free fluid. The swelling in these cases is of a moderate extent and the free fluid of the joint cavity is not purulent in the large majority of cases. However, all graduations from serous to frankly purulent effusions may occur. The roentgenograms show merely the swelling but no bony lesions.

3. Cases of osteo-arthritis. In these cases the adjacent bony structures are involved as demonstrated by the roentgen-ray. The lesions may be

of the atrophic type, usually rarefactions; or of the hypertrophic type, exostoses. Cases of periosteal infections are included.

4. Cases presenting phlegmons. These are rare cases in which the infection is so vehement that the adjacent soft parts show great swelling with marked lymphangitis. Suppuration is common in these cases. They are particularly prone to occur in tendon sheath infections. If they occur in and around one of the major joints, ankylosis is the usual result (13).

The therapeutic efforts have been varied, always a sure indication that nothing has been very satisfactory. For the purpose of a short résumé they may be classified as efforts directed (1) toward the whole organism, (2) toward the primary focus, and (3) toward the infected joint. The first group contains all the so called immunological procedures, injections of gonococcus vaccines, of sera supposed to contain specific antibodies, and of sera supposed to contain specific antitoxins (5, 7, 19, 27). Here also belong the many non-specific proteins which have been used widely in the last 15 years. Horse serum, typhoid vaccine, whole milk, and casein are the more important ones. Even artificial tertian malaria infections have been used to hasten a cure (11, 12, 24). To this group belong also the efforts to eradicate the infection by chemotherapeutic means; acriflavine, mercurochrome, and metaphen being used especially for this purpose (32, 33). The efforts of the second group, namely, the attack of the primary focus, have been mostly along the lines of routine treatment of gonorrhœa. Massages of the prostate and of the seminal vesicles, and irrigations of the lower urinary tract have been widely used and widely sponsored. The attempts to eradicate the focus, by injections of Pregl's solution into the seminal vesicles directly (25, 26), by injections of collargol into the seminal vesicles through the vas, and by radical vesiculectomy, also belong here. The treatments of the metastatic focus have also been multiple and quite frequently contradictory. Many advise fixation of the joint, even for several weeks (6), while many more advise active motion as early as possible (10, 17, 20, 27, 34). The first group is primarily concerned with the pain symptom, the second with the ultimate function of the joint, but both groups claim quicker healing as a result of their therapy. Local heat, including diathermy, various ointments, aspiration of the joint, even surgical exposure and irrigation of the joint have been practised and recommended (3). A newer treatment of the metastatic focus is the roentgenray (3, 15, 18, 21, 22, 31). Nearly all the various treatments will be discussed with the presentation of the material observed.

The material which forms the basis of this report has been taken from the records of Bellevue Hospital in New York. Only the unquestionably positive gonococcus arthritis cases from November 1, 1922, to January 1, 1928, have been included. The cases of the previous 7 years have been reported by Collings (6). Table I gives the number of cases, their classification as acute or chronic (all cases which had had arthritic symptoms for more than 4 weeks were classified as chronic), their disposal at discharge, and the duration of hospital stay. Only those patients who were discharged by the medical staff to their homes can be used for comparative therapeutic statistics. Some patients left of their own volition irrespective of their status and a further number were transferred to other hospitals because of our shortage of beds.

TABLE I.—CLASSIFICATION AND DISPOSAL OF CASES

	Number of cases
Acute cases (513)	
Discharged home	337
Left voluntarily	74
Transferred	102
Chronic cases (97)	
Discharged home	53
Left voluntarily	17
Transferred	27
Total	610

Average stay in hospital acute cases, 19.0 days.
Average stay in hospital chronic cases, 15.5 days.

Grouping all the cases as to their hospital stay, it is seen (Table II) that almost 70 per cent required less than 3 weeks of hospitalization. Practically all the cases when discharged home were sufficiently improved to be able to walk, and since the large majority of the patients suffered from infections in the lower extremities, this is a fair indication of the average hospitalization time required. It seems that this is an extremely important point. Without the careful cognizance of fairly large averages, one is easily misled into therapeutic enthusiasm concerning a small number of cases.

TABLE II.—DURATION OF HOSPITAL STAY IN DAYS

	Number of cases
1 to 10	246
10 to 20	173
20 to 30	85
30 to 40	53
40 to 50	53
Total	610

Only seven of the patients were women; this low incidence is partly due to the difficulty of proving an arthritis in the female to be gonococcic in origin. In the male the proof of gonococcic infection is usually easy. The large majority showed positive urethral smears; the rest showed the organisms either in the prostatic secretion or in the joint fluid.

As stated before, the incubation time, that is, the time elapsing between the appearance of the urethral discharge and the appearance of joint symptoms, is indefinite. Findings based on our experience have indicated that this period is usually fairly short. As shown in Table III, in almost one half of the cases joint symptoms developed within 3 weeks.

TABLE III.—INCUBATION TIME IN DAYS

	Number of cases
1 to 20	302
20 to 60	187
More than 60	84
Unknown	37
Total	610

The statement that no age is exempt is correct, but because gonorrhœa is primarily an infection of the young adult, most arthritis cases occur at that age (Table IV).

TABLE IV.—AGE INCIDENCE

Ages of patients in years	Number of cases
Below 20	29
20 to 30	360
30 to 40	156
40 to 50	57
50 to 60	8
Total	610

The fact that gonococcic arthritis may not appear at the first attack of gonorrhœa but at some later attack is apparently true, since 345 of the 610 patients had suffered repeated attacks of gonococcic urethritis, whereas only 105 patients had experienced arthritis with the previous urethral infection. It did not seem, however, that the repeaters presented more severe attacks as is frequently stated.

The frequently expressed opinion that gonococcic arthritis usually attacks only one joint is probably wrong. Of the 610 patients not less than 410 suffered from multiple joint lesions. It has also been noted that practically every case records multiple ephemeral joint pains before the infection of one or more joints became outstanding. These preliminary, usually rather vague, symptoms were not counted as arthritic in spite of the fact that they probably were.

It is difficult to classify the material according to the severity of the joint infections. The clinical pictures are as varied as those of gonorrhœa of the genito-urinary tract. The classification as to the type of arthritis helps only a little since the large majority belongs to type 2. Temperature is only a fair index of severity, as is pain. However, the attempt has been made to keep all factors in mind when groups of cases are discussed according to the treatment they received. Table V gives an idea of the frequency of temperature rises and also of the pain encountered. "Normal temperature" includes everything up to 99 degrees F., "raised temperature" everything from 99 degrees to 102 degrees F., and "high temperature" everything above 102 degrees F. Since every patient suffered from pain, only those cases were specially selected which required sedatives, and these again were classified as 1, "moderate," 2, "severe," and 3, "very severe." The rest were classified as "mild." There seems to be some relation between the temperature and the pain, but it is not a very intimate one. Aside from these two factors the local joint changes have been considered in an attempt to classify the material into (A) mild, (B) moderately severe, (C) severe, and (D) very severe cases.

TABLE V.—PAIN AND TEMPERATURE

Pain	No. of cases	Temperature	No. of cases	Per cent
Mild	312	Normal	121	38
		Raised	197	58
		High	12	4
Moderate	103	Normal	20	19
		Raised	75	73
		High	8	8
Severe	148	Normal	14	9
		Raised	113	77
		High	21	14
Very severe	47	Normal	3	6
		Raised	37	79
		High	7	15
Total	610	Normal	158	26
		Raised	404	66
		High	48	8

It was quite necessary to do this, since without this classification our therapeutic efforts would appear absurd. It is quite natural to let a mild case go without treatment with the result that the fairly large number of untreated cases makes a far better showing in reference to their hospital stay than do the treated cases. Table VI therefore gives the summary of this classification attempt, and this will be adhered to in the discussion of the therapy.

TABLE VI.—CLASSIFICATION

Degree of severity	No. of cases	No. of cases discharged home	Average stay in hospital of cases discharged home—days
Mild	71	45	7.7
Moderately severe	294	203	13.9
Severe	217	128	27.2
Very severe	28	14	36.3
Total	610	390	18.6

The material in Table VII may be viewed according to the classification into types as described before.

TABLE VII.—TYPES

Type	No. of cases
1	76
2	485
3	44
4	5
Total	610

It is possible that many of the cases of type 2 would have been grouped as type 3 if more careful roentgen-ray studies had been made. As it is, type 3 contains the more severe cases of osteoarthritis and osteitis in which roentgen-ray diagnosis was thought to be essential.

The various joints found affected can be listed in reference to their frequency as follows: knee, ankle, foot, wrist, hip, and so on. Table VIII gives the complete list.

TABLE VIII.

Joints	Number of occurrences
Spine	18
Mandibular	15
Sternoclavicular	15
Sacro-iliac	15
Upper extremity	244
Shoulder	49
Elbow	35
Wrist	101
Hand	25
Fingers	34
Lower Extremity	995
Hip	77
Knee	409
Ankle	340
Foot	118
Toes	51
Heel	63

The preponderance of arthritic infections of the lower extremities over those of the upper is very marked, the ratio being 4 to 1. This is possibly due in part to the fact that patients with arthritic pains of the upper extremities do not apply for hospitalization as readily as those with arthritis of the lower extremities, which makes locomotion impossible. An attempt was made to demonstrate the influence of occupation on the localization of the arthritis. It is possible that joints which are used much and which are exposed to frequent, even if slight, traumas would be more readily affected than other joints which were spared this frequent insult. Unfortunately, we did not have a large enough series of upper extremity workers, as tailors, furriers, machine operators, and so forth, but we did have 73 chauffeurs among the 610 patients. Since a chauffeur uses his legs almost continually in driving, and sometimes strenuously so, his upper extremities, while active also, are doing much less strenuous work. Table IX gives the joint lesions in chauffeurs in comparison to the joint lesions of the total 610 patients.

TABLE IX.—JOINT LESIONS IN CHAUFFEURS

Joints	Number of occurrences
Spine	2
Mandibular	1
Sternoclavicular	3
Sacro-iliac	2
Upper extremity	16
Shoulder	4
Elbow	2
Wrist	7
Hand	2
Fingers	1
Lower extremity	90
Hip	5
Knee	31
Ankle	35
Foot	16
Toes	3
Heels	8

The relation between infections of the upper extremities and those of the lower in chauffeurs is 1 to 5.6, a still greater discrepancy than is found in the total material. There is also a relatively greater preponderance of ankle and foot infections. This seems to indicate that the occupation has something to do with the location of the arthritis, but that it is probably a minor factor.

A few words about other gonorrhœal complications in this group of patients will suffice. Endocarditis has not been encountered in this series. Eye complications have been fairly frequent. The majority of these, numbering 11, were due to direct outside infections resulting in conjunctivitis; only 2 were of the metastatic type. The outcome was favorable in all cases. Twenty-three patients suffered additionally from epididymitis, and one patient developed a periurethral abscess. Three patients developed a severe lymphangitis in the area of drainage; 2 in the groin and 1 in the axilla.

Roentgenograms have been taken in 132 cases. A few of these were negative; the rest showed all varieties of joint lesions from slight enlargement of the joint cavity to bony ankylosis. The peculiar small round decalcification areas close to the joint surface which are supposed to be characteristic of gonococcic arthritis showed many times, but because of lack of comparative material it is impossible to say whether these are really characteristic.

White cell and differential counts were made in 23 cases. These are not at all characteristic. The average count is as follows: 12,300 white cells per cubic millimeter with 77 per cent polymorphonuclears. Fluctuations from 8,300 to 20,800 in total counts and from 64 per cent to 91 per cent in polymorphonuclear counts were found.

A review of particular therapeutic efforts made should be preceded by a careful realization that untreated cases do not fare very badly. Table X illuminates this fact very well.

TABLE X.

Untreated cases	Number of cases	Average stay in hospital days
Total	150	7.9
Cases discharged home	71	8.0
Classified as to severity		
Mild	17	4.1
Moderately severe	44	8.5
Severe	10	13.1
Very severe	..	....

However, these cases had some treatment; practically all of them received daily irrigations of the anterior urethra with an antiseptic solution; whenever the pains were severe, a sedative of some kind was prescribed, and a number of these patients helped themselves by local heat treatment given by means of screened electric lamps which were kept in the ward. None of them, however, was treated by any specific method. They were given rest in bed, 3 meals a day, and practically nothing else. As soon as their pains had abated sufficiently they were discharged home or to the Out Patient Department. On the other hand, it must be admitted that these untreated cases were not consecutive but remained untreated either because of external causes or because their symptoms did not appear urgent. In consequence, these untreated cases are in the average a trifle milder than the treated cases.

The largest group of treated cases is the one treated by gonococcus vaccines. Various types of vaccines were used, but none was autogenous. Most of the vaccines were made by the New York City Board of Health; others were made by Burbank, by the Rockefeller Institute, and by several commercial houses. The initial dose was invariably small, about 5 to 25 million; the increase was gradual and the highest dosage reached was 1000 million. The vaccines were given in intervals from 3 to 8 days and were usually injected subcutaneously or intramuscularly. A small group received intravenous medication. There were no outstanding results. Some of the patients who suffered a marked temperature rise after the injections—this was quite common after intravenous medication—experienced a shortlived relief from pain, identically with the patients who received other foreign protein injections. There was no evidence indicating increase in immunity against the gonococcic infection, in spite of the fact that there was an apparent increase in tolerance to the injections. It was the rule that a patient receiving many injections of gonococcus vaccine finally failed to react in any way to the injections. Even the local reaction, reddening, swelling, and so on, which usually persisted longer during the series of injections than the general reactions such as chills and fever, finally failed to appear. Quite a number of cases had received gonococcus vaccines before coming to Bellevue Hospital; many of these refused the treatment. Altogether it appears as if the somewhat questionable and shortlived result of the gonococcus vaccine treatment is that in common with foreign protein therapy (19). In view of the annoying toxicity of the gonococcus vaccines, however, other foreign proteins are preferable. Table XI gives an idea of the therapeutic result.

TABLE XI.—THERAPEUTIC RESULTS OF GONOCOCCUS INJECTION TREATMENT

Cases treated with gonococcus vaccines	Number of cases	Average stay in hospital days
Total	283	21.1
Cases discharged home	208	21.0
Classified as to severity		
Mild	24	10.0
Moderately severe	103	16.1
Severe	75	31.2
Very severe	6	41.1

The other types of treatment will have to be discussed in groups; there are not enough cases from which to draw statistical conclusions. The efforts to eradicate gonococcic infection by chemotherapy are numerous. Only a few of these have been repeated at Bellevue Hospital. There are really only 3 chemicals which have been tried fairly thoroughly, namely Pregl's solution, mercurochrome, and metaphen.

Twelve patients were treated with Pregl's solution intravenously. Injections of 10 to 40 cubic centimeters were repeated frequently. Some patients received 12 injections, others only 2. There were no untoward effects. One patient developed an acute epididymitis during the treatment. The results were disappointing. None of the patients made a speedy recovery and their average hospitalization was 37 days. Fourteen patients received intravenous injections of 1 per cent mercurochome solution. The dosage varied from 3 to 5 milligrams per kilogram of bodyweight. The number of injections varied from 1 to 5. There were no serious untoward effects. However, temperature rises to 104 degrees F. were common; some of the reactions were accompanied by a temperature rise to 105 degrees F. Vomiting occurred three times. Albuminuria was observed a few times shortly after the injections; hæmaturia was never seen. One patient developed an acute epididymitis during the treatment, but none of the patients developed infections in new joints. The results were fairly good. Recovery seemed to be slightly hastened and seemed to be slightly more complete than in other similar cases. The average hospital stay was 18 days. Metaphen solution was used in 15 cases intravenously. The dosage was always 10 cubic centimeters of a 1:000 solution which is put up in ampoules. Injections were repeated from 2 to 5 times. There were no untoward and no therapeutic effects. Two of the 15 patients developed new joint infections after the treatment had been started. This seems to speak very strongly against any general antiseptic effect of the medication. The average hospital stay was 21 days. Altogether our chemotherapeutic efforts have been disappointing.

Another group of therapeutic endeavors which has been used very widely is "foreign protein therapy." A great variery of substances has been used. It is at least questionable if substances such as gonococcus vaccines and mercurochome should not be placed here also. Both frequently produce body reactions which are sought for in foreign protein therapy and their therapeutic efficiency seems to depend somewhat on those reactions. It is impossible to go into the theoretical and historical aspect of protein therapy; suffice it to say that this therapy constitutes an attempt to accelerate the complex defensive mechanism of the body by giving it a protein shock. The type and quantity of shock is debatable, but most efforts are directed toward a temperature rise of some magnitude. Whatever else goes with this seems to be not only acceptable but is considered now to be the primary therapeutic factor. The illusion that a high temperature *per se* kills the gonococcus has been shattered. In our series typhoid vaccine has been the principal foreign protein. It has been employed in 31 cases; in all cases except 5 it was used intravenously. The initial dose was usually 25 million organisms, and this dosage was gradually raised to even 1,000 million to get the desired temperature rise. The number of injections varied from 2 to 13. The reactions were as a rule vehement and intensely disagreeable for the patient. Chills were usually very marked and so was the accompanying malaise. After the reaction, which was usually ended in 6 to 8 hours, the patient felt markedly improved. The pain in the joint was nearly always appraised as lessened. But there were no objective changes in the joint condition or at least not more than the gradual diminution of swelling which is seen in almost all cases. It is surely debatable if the subjective improvement in the patient's condition is not due to a psychological mechanism. He is so wretched during his protein shock that his primary sickness impresses him less than before. The fact that usually a slump in the patient's subjective condition appears after 2 to 3 days corroborates this. Recently several reports have been published praising tertian malaria as a therapeutic agent in acute and chronic gonorrhœa (11, 12, 24). The reports have not been very convincing and it was not deemed feasible to employ such heroic weapons, but it was possible to produce almost typical tertian malaria temperature curves with graduated intravenous injections of typhoid vaccine which were given every second day (Charts 1 and 2). The results were disappointing; aside from this, the treatment is so rigorous that one would rather prefer the disease to the therapy. The average hospital stay of the patients treated with typhoid vaccine has been 24 days.

The other foreign proteins have been used in lesser numbers. Casein has been used 9 times, whole milk 3 times, the patient's own joint fluid (10 to 40 cubic centimeters) 5 times, and the patient's own blood (20 cubic centimeters) 10 times. The literature on these foreign proteins is large and mostly enthusiastic (1, 8, 9, 23, 28, 30). However, our own results have been negative. This is particularly true with the intramuscular joint fluid and whole blood injections. There were no results, except the patient's discomfort where the substances were deposited, usually in the gluteal muscles. This is really surprising in view of the highly laudatory reports on *Eigenblutherapie*. Aolan and milk are slightly more efficient. Reactions are not as regularly elicited as

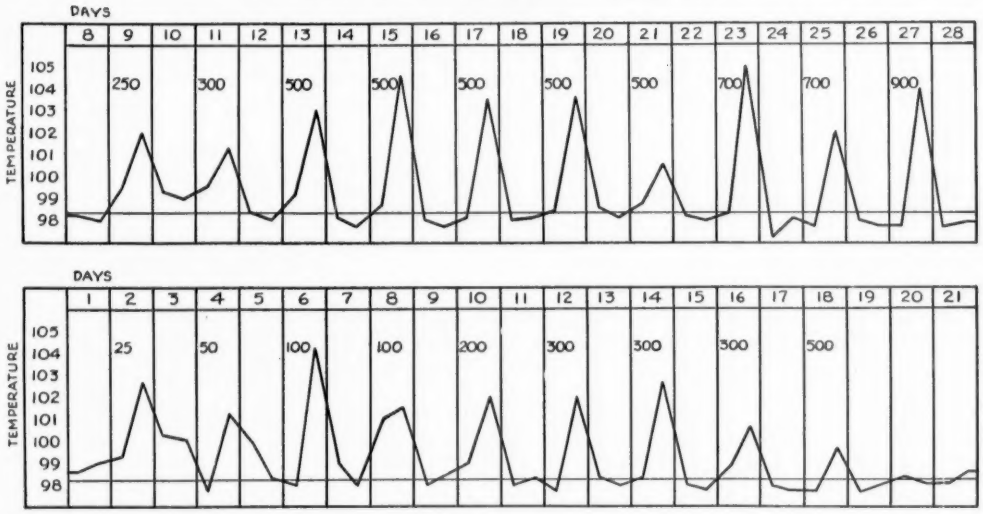

Chart 1. Curve showing effect produced by injection of typhoid organisms on alternate days. The numbers indicate millions.

Chart 2. Effect of injection of typhoid organisms.

with typhoid vaccine, but when they do occur they are followed by temporary improvement. Milk has the drawback of being always contaminated and, aside from the fact that the dead bacterial bodies may be toxic, it cannot be safely sterilized. The average hospital stay of patients treated with foreign proteins other than typhoid vaccine was 19 days.

Only a few times has the focus of infection been the center of the therapeutic attack. After the enthusiastic reports of Stellwagen on the treatment of gonococcic arthritis by the injections of Pregl's solution into the seminal vesicles, this method was tried in 3 cases. Every patient received 3 injections into both seminal vesicles at intervals of 3 to 4 days. There were no effects discernible in reference to the arthritic condition. One of the patients developed a short termed hæmaturia after the second injection. In each case perivesicular infiltrations could be felt several days after the last injection. It may be said that the seminal vesicles are neither the most common foci of infection nor is the infection ever limited to the seminal vesicles.

Systemic prostatic massages, namely one every 3 to 5 days, were carried out in 30 cases. Four times fairly high temperature reactions occurred after the massage. There were no evidences that the treatment had any influence on the arthritic condition. The average hospital stay of the cases treated thus was 22 days.

The local joint condition has always demanded the greatest attention and, while an arthritis really belongs to the field of orthopedic surgery, the urologist usually cannot avoid carrying out some therapeusis. At Bellevue Hospital the attempt was usually made to relieve all severe pains. The most reliable means for doing this is a well applied cast. Casts have been used on 144 joints. The average time of immobilization was 10 days. Fifteen times the cast had to be renewed and 7 times the cast had to be removed on account of increased pain. The immobilization apparently had no influence on the time of invalidity but relieved the pain successfully in almost all cases. As already pointed out immobilization also has its drawbacks. The numerous favorable reports on the use of early active motion of the affected joints for therapeutic purposes deserve attention (10, 14, 20, 34). They come from reliable sources and concern a method which arose on the basis of sound pathological and clinical observations. The technique usually employed is as follows. As soon as the patient can possibly be moved, he is lifted into a very hot bath and is asked to execute active motions of the affected joint. This is usually possible due to the relaxation in the water bath. The claims are quicker recovery and fewer ankylosed joints. It is unfortunate that due to circumstances this method could not have been used.

Lately the deep roentgen-ray has been tried

for the relief of pain. Our dosage has always been 25 per cent of a skin erythema dose with copper and aluminum filters. Cross fire was used invariably and the treatment was usually repeated after an interval of one week. Of the 27 patients on whom the treatment was used, 22 reported a marked relief from pain after the first treatment, 2 after the second treatment; 3 were not relieved. The average patient received 2 treatments; 8 patients received 4 treatments, the highest number given. If several joints were involved and only one was treated by roentgen-ray, only the one treated was improved. The roentgen-ray treatment did not have any apparent influence on the time period required for recovery. However, the fact that the treatment relieved the pain in many cases without fixation is encouraging. The mechanism of this effect is debatable. It is certain that the roentgen-ray does not kill the gonococcus. The observation that the roentgen-ray in large doses diminishes the fibroblast reaction and destroys primarily the endothelial elements may be explanatory in the sense that certain phases of the inflammatory reaction in the joint are diminished with a consequent decrease in swelling. It may also be that the above named elements are not destroyed by the relatively small roentgen-ray dosage, but rather that they are stimulated in their activity, which is primarily that of defense against the invading organism. The fact that even very small doses have been successful, namely, doses of 5 to 8 per cent of the erythema dose, would speak for the latter explanation.

CONCLUSIONS

In conclusion it may be said that we have no specific treatment for gonococcic arthritis at the present time. The primary consideration in planning the treatment should be the end-result, namely, the unimpaired function of the joint. This end-result may be endangered by fixation. On the other hand the outstanding distressing symptom, pain in the joint, is relieved most efficiently by fixation. It seems that the roentgen-ray will prove very helpful here, and it is also likely that the principle of early active motion which has been so beneficial in other pathological joint conditions will also prove its worth in gonococcic arthritis.

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CORRESPONDENCE

PANHYSTERECTOMY TECHNIQUE

To the Editor: In your February issue Dr. E. H. Richardson, of Baltimore, describes what he calls a "simplified technique" for abdominal panhysterectomy. In his article he mentions the technique which I presented in detail in 1916, at the meeting of the American Association of Obstetricians, Gynecologists, and Abdominal Surgeons, and compliments me by stating that my method is better than any which had been previously devised. My paper was published in the *Transactions* of the Association and also in the *American Journal of Obstetrics and Diseases of Children*, vol. lxxv, No. 2, 1917.

I have studied his article with very great care and have discussed it with several of our local surgeons who long since have adopted my technique. In some of his details we agree perfectly, but in others we do not, and I think the latter are subject to comment: (1) He emphasizes the importance of separating the rectum from the upper end of the vagina, so that he can sever the vagina below the tip of the cervix. Normally the rectum is not attached to the vagina for about one inch at the upper end, so that there is no necessity whatever for making any further separation, such as he pictures in Figure 6. Indeed, the rectum is frequently separate from the vagina for at least 2 inches, so that repeatedly I have taken advantage of that separation in complicated cases to split the posterior vaginal wall downward, after removing the uterus, in order to introduce the ends of a gauze fluff (over which is attached the mobilized sigmoid) which is to be withdrawn, after one week, through the vagina. (2) He frees the uterus so extensively that by compressing the vagina anteroposteriorly by the fingers he brings its walls together below the cervix, as shown in Figure 7, and then in cutting across he cuts so far below the cervix, as shown in Figure 9, that the vagina is necessarily shortened by nearly or quite one inch. By my technique, the entire length of the vagina is utilized; by his technique the shortening of the vagina must necessarily result in more or less dyspareunia and thus prove a fatal objection. (3) In separating the parts posteriorly we both detach the uterosacral ligaments, but in completing his operation he directs that these ligaments shall be "clamped, divided, and ligated close to their cervical attachments." By my technique these ligaments are replaced as nearly as possible in their normal relationship to the parts and they are utilized in peritonealizing the pelvic floor.

None of us here can see how by his technique there is any diminution in hæmorrhage, any less danger of infection from the vagina, and most certainly no gain in time.

In conclusion, my operation was originally based on over two thousand hysterectomies, has been demonstrated to large numbers of surgeons from whom it has received the warmest approval, and with an added experience of several thousand cases I have seen no reason to make a single change in the technique as published. I more and more, however, emphasize the importance of thorough *personal* preliminary cleansing and sterilization of the vagina and endometrium. I very recently went over all of my deaths following panhysterectomy, and in not a single instance could death be attributed to any infection coming up through the vagina. Hæmorrhage is negligible. In ordinary cases there is no shock. No ureters have been injured. In simple cases the operation has been repeatedly completed in 15 minutes.

J. F. BALDWIN, M.D.

Columbus, Ohio.

EDITORIALS

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JULY, 1929

THE TREATMENT OF VARICOSE VEINS

UNPRECEDENTED interest has been aroused in the ambulatory form of treatment for varicose veins. This disease, which permits the distinct recognition of a hereditary disposition but is aggravated by traumatic, infectious, and postural factors, is more widespread than our operative records would indicate. Of one hundred consecutive cases, 75 per cent of the patients would not consider operative treatment, partly because of lack of time but chiefly because of the *horror scalpelli*. While the disease may start in patients in the early twenties, it will not produce disturbing symptoms for many years; yet as the disease progresses, as the phlebitis, the eczema, and the ulcer develop, these incapacitating conditions will mean months and years of economic loss to the patient. The varicose ulcer, the *crux medicorum* wanders from doctor to doctor, from hospital to hospital, and the treatment of such end stages is long and disappointing.

An ambulatory form of treatment then, undertaken previous to the onset of complications and permitting the patient to continue his or her daily duties, means real progress in treatment, provided the method is safe and effective.

The safety of the injection treatment is maintained first of all by selecting the suitable case. Acute superficial phlebitis and deep thrombophlebitis are definite contra-indications. Hyperthyroidism and acute tuberculosis supersede in dignity and importance all local treatment for veins and should be attended first. Many other diseases, such as diabetes and hypertension, are not a contra-indication and should be treated simultaneously. But most important is the early recognition of partial or total arterial occlusion, which is associated so frequently with dilated veins. Patients with impending juvenile or senile gangrene should be carefully excluded from the injection treatment. The safety of the injections is furthermore enhanced by using sugar solutions, dextrose, and invert-sugar, as perivenous injections will not result in necroses, as frequently reported after the use of other hypertonic or chemically highly irritant substances.

The effect of hypertonic sugar solutions is an irritation of the intima which becomes hyperæmic and œdematous. With the help of adequate compression following the injection, the inflamed walls of the vein are approximated and a fibrinous exudate seals the lumen of the vessel. In this fibrinous network the blood will clot, secondarily to the endophlebitis. This is quite an important factor in the firm adherence of the clot, as the clot is really organized from the very beginning. Histological studies have been made comparing

such clots with thrombi occurring spontaneously, the so-called static thrombi of Aschoff, and the latter show a tendency to organize very slowly.

When we consider the comparatively high incidence of pulmonary embolism following radical removal of varicose veins, when we consider the almost entire absence of saphenous thrombi as the source of fatal pulmonary embolism, when we consider the important fact that these patients are not immobilized at all but are encouraged to pursue their daily work, thus eliminating the factor of stasis in the formation of "spontaneous" clots, we can feel justified in advising the injection treatment, even if the theoretical possibility of a thrombus breaking loose is to be admitted. However, if such a thrombus becomes infected, or if massive thrombi are produced close to the saphenofemoral junction, where the sucking action of respiration can be demonstrated, the danger of embolism must become greater.

Preliminary ligation of the long saphenous vein, previous to injections, or radical removal of all visible dilatations after a ligation at the saphenofemoral junction, are very useful procedures and are still employed in selected cases. No new method can ever displace entirely the fruitful work of master surgeons, who have contributed to the surgery of varicose veins. The injection treatment is simple, safe, effective, and economical, but will be rapidly discredited, unless used in its proper place.

GÉZA DE TAKÁTS.

JEJUNAL ULCER FOLLOWING GASTRO-ENTEROSTOMY

JEJUNAL ulcer is one of the most dreaded and perplexing complications of gastro-enterostomy, although fortunately it does not occur frequently—probably nearer 2 per cent (Mayo) than the 6 to 10 per cent mentioned by Lahey. It occurs at or near the line of anastomosis, generally in the efferent branch of the jejunal loop, but sometimes encroaches upon the stomach itself. It gives rise to very disturbing symptoms similar to those of duodenal ulcer, the pain and tenderness, however, lying more to the left.

Jejunal ulcers are difficult to demonstrate with the X-ray, although they often are of considerable size and embedded in massive adhesions. They may extensively involve the surrounding structures, such as the colon, into which they occasionally perforate.

If medical treatment fails, which it is apt to do, one of several operations can be done, perhaps preceded by a preliminary jejunostomy, if the patient's condition demands it (Balfour):

1. The anastomosis may be undone, the diseased bowel resected and re-united, and the opening in the stomach closed, thus re-establishing the *status quo ante*.

2. After the anastomosis has been undone and the ulcer excised, a new gastro-enterostomy may be performed, although there is always danger of a recurrence of the trouble.

3. When possible, a partial resection of the stomach may be done, including most of its acid-bearing area together with the anastomotic opening and a section of the diseased bowel, but even this does not always prevent a recurrence.

4. In case of a colonic fistula it may be necessary to resect a portion of the colon along with the small bowel and stomach.

Manifestly these are all more or less formidable and dangerous procedures, especially following a no-loop posterior gastro-enterostomy.

In order to prevent jejunal ulcer we should know its cause. A number of theories have been suggested but none of them is entirely satisfactory:

1. *Traumatism and submucous hæmorrhages from crushing of the tissues with holding-forceps.* This would seem reasonable if it were not for the fact that jejunal ulcers occur when forceps have not been used and other forms of traumatism have been avoided.

2. *Non-absorbable sutures.* Unfortunately, their abandonment in favor of catgut has not done away with the trouble.

3. *Imperfect suturing.* This occurs in other gastric operations and ulcers do not result. Furthermore, the jejunal ulcers often do not come in contact with the suture line.

4. *The acid gastric contents* which pass directly into the non-resisting jejunum. This would seem to be such a reasonable solution of the problem that many surgeons, especially abroad, have widely resected the acid-bearing area of the stomach, sometimes removing so much that the remainder was insufficient for the requirements of the patient; but numerous reports have shown that ulcers have occurred in spite of these extreme operations. In fact, the removal of what was originally the acid-bearing area does not prevent the remainder of the stomach from developing acid-forming functions and, in addition, jejunal ulcer may appear when little or no acid is present, or even when no gastro-enterostomy has previously been done.

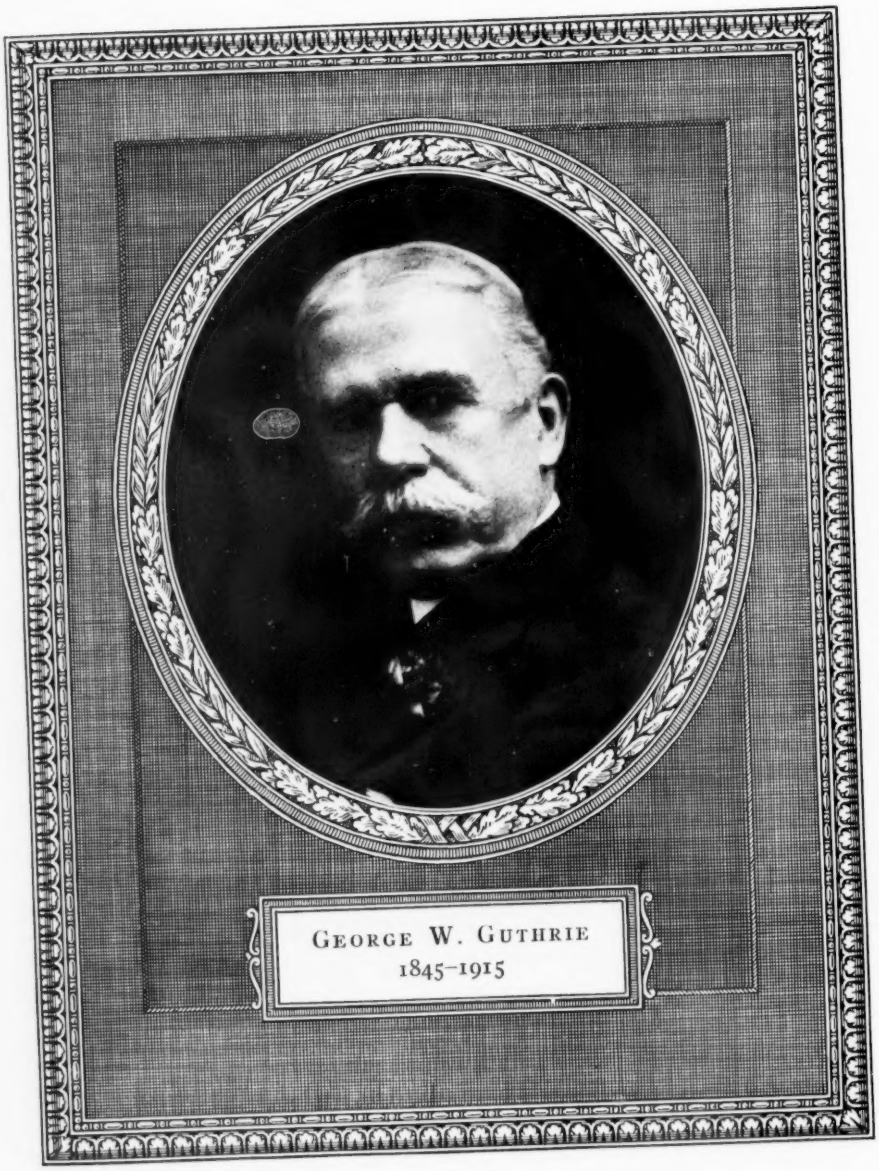
5. *Disturbance of innervation.* The principal support of this theory seems to be derived from experience with von Eiselsberg's procedure of permanent closure of the pylorus in gastro-enterostomy, which was found to augment enormously the incidence of jejunal ulcer. This could hardly be caused by an increased flow of gastric contents through the new opening, because ulceration does not occur frequently when the pyloric obstruction arises pathologically. Hence, it was thought that it might be due to a disturbance of the innervation about the pylorus leading to changes in the pancreatic and gastric secretions. However, even if we admit the truth of this explanation in von Eiselsberg's operation, it is difficult to see how it applies when the pylorus is not interfered with. Furthermore, division of the autonomous nerve supply has even been suggested as a cure for ulceration.

6. *Constitutional predisposition.* This would, of course, explain the phenomenon, but until more convincing proof is presented it would seem to be a begging of the question.

Apparently, there is no certainty regarding the etiology of jejunal ulcer and no way of preventing jejunal ulcer when a gastro-enterostomy is done. All of the causes mentioned, and perhaps others, may play a part, but none of them seems to be a constant factor. Hence, in addition to avoiding these causes, it seems evident that we should try to plan our operations so that if recurring ulcers appear, we can subsequently take care of them without too much danger and difficulty.

At a recent meeting of the American Surgical Association, Dr. Balfour of the Mayo Clinic emphasized this view, advocating gastro-enterostomy or limited resections (Billroth I) when practicable, instead of the more extensive procedures, claiming that the results are sufficiently good while the mortality is lower, and that in case further ulceration appears the operative outlook is better.

LEONARD FREEMAN



GEORGE W. GUTHRIE
1845–1915

UNIV. OF MICH.

MASTER SURGEONS OF AMERICA

GEORGE W. GUTHRIE

A GENTLEMAN of the old school, a surgeon of distinction, a cultivated leader of his community, a staunch and devoted friend. In this mental picture, still so vivid, of Dr. George W. Guthrie, who died at Wilkes-Barre, June 1, 1915, these attributes seem to portray his character. Born in Guthrieville, Chester County, Pennsylvania, he was a descendant of Scotch Presbyterians who had emigrated and settled in Eastern Pennsylvania early in the eighteenth century. He began his career as a teacher in the Public Schools and, because of his practical experience and interest in educational problems, he became a director of the school board, in which capacity he served for forty years and impressed his leadership on the reorganization and direction of the Public School System. In his twenty-fifth year he first turned his attention to medicine, beginning his studies under the old preceptor system and graduating later from the University of Pennsylvania.

It is difficult adequately to sketch the career of the man, who, as I affectionately recall him, represented an ideal, a prototype of what seemed finest and best in the profession of medicine. It was not so much that he had attained distinction in practice, first as family physician and later as surgeon—this was recognized by the community who elected him to the staff of the Wilkes-Barre City Hospital and consulting surgeon on the staffs of hospitals in adjacent communities; it was recognized by exclusive organizations as when he was chosen a Fellow of the American Surgical Association. It was the associated attributes, attributes which round out a man no matter what his profession, which made George W. Guthrie admired, respected, and beloved. In the blood of his veins there ran a strict sense of all that was honorable in manhood. All that he said rang so true and all that he did was so untainted with selfish interests, that he soon became the confidant and friend and the leader, guide, philosopher and friend, if you choose, of his associates. He was, in fact, the dean of the medical fraternity throughout the Wyoming Valley and it was largely the reflection of his influence that in Wilkes-Barre there was during his day a very unusual group of splendid physicians and surgeons.

He recognized, as few do, his obligations to organized medicine and carried much more than his share of the responsibilities of upholding the standards and

ideals of medical practice and scientific pursuits. Holding high office in city, county, and national societies, he served on committees and commissions too numerous to mention. He played an important part as a member of the House of Delegates during the years that the American Medical Association was in process of becoming the effective organization it now is; finally declining reappointment in 1913 to become a member of its Judicial Council.

All the while he was giving of his time to his large and exacting practice, to his community obligations, and to the demands of the medical organizations with which he was allied.

He was essentially a student of medicine, and was well informed in current literature to which he was no mean contributor. In reviewing his writings one can see that not only was he abreast of the times but foresaw with a clear vision the tendencies of progressive thought. His writings were examples of good diction and there was a charm in his style, especially in his general addresses to physicians and nurses which were replete with wholesome advice. His *By-Paths of the Doctor's Life*, a charming paper written in 1904, might today be read with profit and to the betterment of many a physician's life. In 1880, at a time when Listerism was engaging the attention of surgeons throughout this country and Europe, he presented his "Essay on Antiseptic Surgery" to the Luzerne County Medical Society. It was a carefully prepared, instructive paper with expressions of opinions from the leading surgeons of the country. At this time some surgeons still doubted the "germ theory of disease," others questioned the efficacy of antiseptic treatment, placing greatest reliance upon absolute cleanliness. Guthrie preached to his fellow practitioners that, in operations of unusual gravity as in opening the peritoneal cavity and the joints, the surgeon who does not follow the exact Listerian method does not give his patient the benefit of the best resources of his profession. As long ago as 1899, many years before the employment of the trained anæsthetist, he recognized as unconscionable the habit of surgeons entrusting the administration of anæsthetics to junior members of the staff. "The custom of placing the anæsthetic in the hands of the youngest man in the operating room—often the merest tyro—is most irrational"; and "Next to the man who holds the knife is that of the one who holds the inhaler." How prophetic these commentaries! At that period he decried the practice of tinkering operations on women with neurasthentic disposition, such a sequence as nephrorrhaphy, Alexander's operation, hysteropexy, double oophorectomy in one and the same patient. He lived and practised at an interesting period in the evolution of surgery, he saw the passing of the nineteenth century and the first fifteen years of the twentieth. As the sun of the nineteenth century had almost set he wrote: "How the pulse thrills when we consider what belongs to the last hundred years. The dreams of ancient and mediæval poesy have been more than realized! Chariots and horses of fire! We have harnessed the lightning and hitched it to tens

of thousands of chariots! Arthur's sword Excalibur! What is that to the sterilized scalpel of the surgeon! And Aladdin and his wonderful lamp are far outdone by the wizard Edison with his electric lamps and by Roentgen and his rays."

There was Guthrie the surgeon, Guthrie the leader of his medical community, Guthrie the lover of good books and poetry. He not only appreciated the broadening effect of familiarity with good literature, history, and romance, but he loved poetry. Proud of his Scotch ancestry, he revelled in the romantic history of Scotland and her great men, but, of all, Robert Burns and his poetry held first place in his heart. His conversation and friendly greetings and his more formal after-dinner speeches were given an added charm by the freedom with which he quoted at random from his favorite authors. How few there are today who could match him, none who could excel.

William James once wrote: "I am done with great things and big things, for great institutions; and I am for those tiny molecular moral forces that work from individual to individual, creeping in through the crannies of the world like so many soft rootlets or like the capillary oozing of water, but which, give them time, will *rend the hardest* monument of man's pride."[1]

Thus do I conceive the influence of Guthrie's life. There were in his community no great institutions or large movements, but the tiny ripples of his influence spread, through his contacts with physicians of state and nation, over the length and breadth of the land. Thus the force of his character left its imprint for the good of his profession and for the making of a better world.

CHARLES H. FRAZIER.

[1] William James. The New Quest by Rufus Jones, page 92.

THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

ALFRED BROWN, M.D., F.A.C.S., Omaha

HUGO OF SIENA. THE COMMENTARIES AND CONSILIA

ONE can hardly imagine a more apt and concise summing up of the medicine and surgery of the fifteenth century than that of Daremberg when he says: "the fifteenth century (more dogmatic, more decided than the fourteenth) was a summary and a preface: a summary, because it presents to us, in all possible forms and modes of expression, the substance of Arabian medicine, of a medicine which is, in its general form, only a transformation, only an assimilation of Greek medicine, especially the medicine of Galen:—a preface, because in certain aspects, quite obscure it is true, it permits a glimpse, especially toward its close, of some tendency toward the observation of nature in the "Consilia" (collections of observations, or consultations), and the dissection of some bodies." It represents a period of dark before dawn and in its early part, at least, an interval of marking time until the discovery of printing allowed a wide dissemination of knowledge at a cost which made it accessible to other than the very rich. One does not look then for marked surgical progress during this century and no great man appeared to force it. There is a modicum of excuse for the condition in the make-up of the universities in which medicine was taught and the difficulties under which the teaching had to be carried out. The professors had to teach from the manuscript books they had at hand and one can visualize each student being required to transcribe his manuscript with the additions and emendations of the master,—a most laborious and time consuming process. Consequently the literature of the period affords us many examples of the works of Hippocrates, Galen, and the different authors of the Arabian school, each one added to, emended, and explained by the teacher, who was usually one of the great men of the time. The literature affords also examples of the "consilia" written by these men; recitals of cases occurring in their experience, case records, so to speak, which were used by them in their teaching and which the students transcribed as their notes.

The work of Hugo Benzi or Hugo Sinensis, so called from his birthplace, Siena, represents a typical example of this form of literature. He was a teacher in great demand for he passed from school to school being called from one to another by the noble in power in the town in which the teaching institution was situated. He was born in the fourteenth century, a member of a prominent family, and graduated in medicine at Siena. He then began to travel from one university to another, always teaching—in 1399 at Pavia, from there to Piacenza, then Florence and in Bologna from 1402 to 1427. He then passed to Parma and Padua. In 1428 the Senate gave him permission to teach in Perugia for two years, after which he returned to Padua but remained for only a year when he went to Ferrara. He was there at the time of the great council and had the opportunity to attend and learn the doctrines of the great philosophers, such as Plato and Aristotle, through listening to the arguments and expositions given at the meetings. When he died is not certain but it was probably about 1439.

Hugo wrote Commentaries on the works of the Ancients but also gives us two books of his own experiences, entitling them "A most useful Treatise Concerning the Regimen and Conservation of Health" published at Milan in 1481 and "Very Healthful Councils for all Diseases" published a year later (Bononiae), 1482.

In what little surgery Hugo writes about he differs hardly at all from the work of the ancients and offers practically nothing new. He is fond of carrying on long arguments which usually lead nowhere, as he does when he is discussing the Aphorisms of Hippocrates. After giving his own beliefs he quotes the ideas of Galen concerning the aphorisms one by one and at the end of each, one is as much in the dark as before reading the explanations. For example, Hugo takes up one page and devotes another to the quotations from Galen in the discussion of the famous first aphorism of Hippocrates: "Life is short; Art is long; Time is pressing; Experience is fallacious; Judgment is difficult." When the discussion is over one still can read the aphorism and translate it to his own satisfaction in hundreds of different ways. Nevertheless, Hugo's ideas are ingenious though one cannot always agree, but they show that he spent much of his time in abstract argumentation which led nowhere. In spite of this he was well thought of by his contemporaries and achieved a great reputation.

For a time at Padua he taught anatomy using human material for demonstration but made practically no progress beyond the then accepted anatomy of Mundinus.

¶ Incipit Expositio clarissimi doctoris Ugonis Senensis super Aforismos Ypocratis & super Cōmenta Galeni eius interpretis.

Recedentis anni incubrationam munus q̄bus parum? mo noi Nicolae Este filio Illustris Marchio Ferrarie dedit: ad futurā mi gloriā?. Si qd meus labor illi addick possit nō q̄ in illis (vt in poetarū versibus: aut hystoricor? lris tue singularissime virtutis eximia facta exprimant.) sed sigd dignum memoria in medicina ?nulero qō ad posteros manet erit testimoniū gēris tue collocādis boibus studio lrar?. Tua.n. indulgēcia & Magnifici viri Ugutionis veri amici diligēcia ta? multos pclaros boles lrarū q? magistros in ciuitatē Parmensem ?uocasti pro studio vt sit indignū nihil ad tāte rei memoriā relinqui posteris. Agam pro viribus in parte satisfacere. Etsi in tanta doctor? multitudine res mee in obscuro future sint. nā nobilitate & gloria doctor? quos dic habes: etiā qui nole meo efficient: ?soloz. Precedentis ergo anni opa ad expositionē tegni Gal. data est: bus? anni ad aforismor? Ypocratis explanationes instabūt vigilie: vbi ?ferā quoad potero brevitatez que rez cognitionē nō offendat. Atq? illud vnū a te oblecro vt si minus accurata q̄ tuo nomi dicanda esset fuerit. recipias tū benigne. Conferā. n. in illud q̄tū opere potero cū Ypocratis pbor? olim: sed certe medicor? pncipe dicta: & eius Commentatoris Gal. nō solū exponēda. sed etiā reb? illustrāda circūstātibus scripseris. Et vt decet ante initiū opis opē a te scisime De? posco & ozo ac efflagito: qua dirigas mē tē ad ea dicēda: q̄ tuis opi & veritati: tū etiā audientiū aias & lector? ?formia pficiant. Aforismus. I.

Vita brevis: ars vo longa: tempus acutum: experimentum fallax: iudicium autem difficile.

¶ Iste est liber aforis. Ypocratis. in quo intēdit Ypocras. nō vlr totā artē tradere: sed ponē in variis ptib? scie medicine q̄dā verissimas & vtilissimas sn̄las sub cōpendio quātū est possibile. Et ex his p? p̄mo titulus istius libri: q? liber aforis? Ypocratis. & significat hoc nomen aforismus p̄m Isidor? 4° etymologiar?. sermonē brevē vel ?positē sn̄las totā explicātē. P? 2° nomen auctoris q? Ypocras Cous. nō fuit ille alius Ypocras filius Euclidis. P? 3° libri subm. nā est idē gō totalis scie medicine. s? de isto nō in isto libro cōplet scia. P? 4° istū libū iter libros medicinales: quos habemus Ypocratis esse p̄mū. q? cū reliq oēs circa vnā ptē versent artis: vt pnosticor? regimis acutor? & alij: iste vlr circa oēs vagat. P? 5° vtilitas. nam cōtinet plura vtilissima circa vtia documēta artis mō quo possint facillime memorie cōmedari. P? 6° cui pti pōle supponat: nā pōle nāli quē admodū p? totalis medicine supponit: & bis modicis p demialibus sum ?tentus. ¶ Diuidit aūt iste liber in pheniū & tractatū qui icipit seqnti aforis?. In peturbationib? vētris. P̄ns aforismus diuidit in duas ptes. Nā p̄mo p bat libros breues esse cōponēdos in medicina. 2° ostēdit ?ditiones requisitas ad verificādū in ope ea que in isto libro ?tinent. ibi 2°| Ops aūt. ¶ In pte p? vult ista ?clionem. Ops in medicina cōponere libros aforis? brevitate. pbat sic. In arte q̄liber longa respectu vite humane est opportunū tales libros cōponere. sed medicina est ars lōga respectu vite humane que respectu artis illi? é brevis. igit 2°. maior est manifesta: q? sine talib? libris nō possumus memoriter bonas sn̄las tenē. & minor pbat. q? ois ista ars est lōga que ds acgri p experiētā faciēdā plimaz rez in tpe acuto & brevi cū timore. & vlra B p rōnem. s? medicina est huiš. g̃ 2°. ¶ Et ps assumptū: q? in talib? artib? Fs modicā vite nre ptē facim? exprimētū pp timorē & tpis brevitatē. etiā in eisdē rō cōplēdi est difficilis: cuz in illa videam? plimos sapientes discordare. g̃ talis est lōga respectu vite nre. Est g̃ ac sī Ypocr. dicat in medicina ops cōponē libros aforisticos. q? bois vita est brevis respectu illi? artis & ars est lōga. & cā logitudis artis est: q? tps in quo spāl? opamur circa corp? nr?z opationē é brevis. nā variant dispones corpis humani frequēter. & ppter ea ops variare opationes. ¶ Scōa cā est: q? experimēt?z est tinozosuz pp qō medicus opat. Et iō nō miltoties se exponit ad pbādū res. ¶ Et 3ª cā é: q? rō regista ad artē babēdā est difficilis. ¶ Circa istā ptē notādū p̄ q? ls vita q̄nq? sumat p opatione sube? intellectualiū vt iz° meta. cōmēto 28°. q̄nq? vo p opatione culuscūq? alat̄: vt z° de ala. q̄nq? pātia ale vegetatiue in corpe: vt in lib° de morte & vita colligit q? est pmāsilo ale vegetatiue in calo nāli. Dic vo sumit 3° mō etiā put ad boles 3hat. hec aūt vita pōt dici brevis & lōga diuersimode cōparata. Nam si cōparat ad plurīa alioz alatiū vitā tūc est lōga. Logissime. n. vite alatiū elephas & hō: vt in libro de lōgitudie & brevitate vite. sed si cōparat cognitioni q̄rūdā artiū est lōga sicut arti sutorie & sīlib?. Cōparata aūt multis durationib? etiā mōtiū & fluminū est brevis. Iterz comparata cognitioni mīt? artiū & pcipne p iuētionē est brevis vt respectu medicine. Nā nullius bois etas sufficeret ad hāc artē inuenīdā & cōplēdā: & B itedit Ypocr. in ista p̄ ptiacula. ¶ 2° notādū q? B nomē ars cquoce sumit. q̄nq? enī sumit large p oi bīu vero stellect? ordiato in facē. i. in capiēdo facē. put distinguit 3 agere pro opatione nō ?cernēdo et? honestatē vel turpitudinē: & isto mō medicina. logica. & grāmatica sunt artes. 2° sumitur stricte ? habitu cū recta rōne factiuo: q? imediate iter bīus it. ? lectus directiuo in op? dictū. & B mō nulla scia est ars. vt pōt colligi 6° ethicor?. Nec isto mō scia medicine est ars: s? bn̄ bīuo practicus acgsitus ex opationib? etiā pticularibus meditationib? in curis ifirmor? p quē pmptē & recte cū rōne opamur ars est. Et tu de B vide qd diceris p tegni. & B sumit ars p mō. Duplr artes dār lōge alys artib? cōparate aut rōne tpis regsiti ad eaz acgsitionez cōpletā. & isto mō medicina est ars lōga pcipue q̄ ad acgsitionē ei? p viā inētionis. p vlā ?o quo ad acgsitionē ei? p doctrinā est lōga: q? plm tpis ops in ea agrēda ponē: nō q? sit lpole ad ei? sufficiētiā in vita humana venire: vt 4° Almasoris. cap. vlt̄. Et in talib? artib? vt rez pteritaz rū habeaf ?tinua memoria regrit ordo librorz breuiz aforis. ¶ 3° notādū q? ars medicine duob? instris acgrit Fs melioē sectā medicor?. s. experimēto & rōne: vt colligit a Gal. in cōmēto p̄mi regimis acutor?. 3° etiā terapētice. ¶ Exprimētū est q̄dā pticular cognitio ex mltis memoryis collecta: vt pōt colligi in pheniō meta°. nec est idefinita cognitio cogitatiue vtut: vt dicit Marsil?. nā cēt cōis: etiā talis non esset in cogitatiua cū sit corpea vtus. ¶ Preterea cognitio illi? idefinite nō plus ?fert ad pn̄cipiū artis acgrēde q̄ vna sola singularis. g̃ 2°. Et g̃ cognitio copulatiue ex mltis singularib? memoratis & pbatis luicē sīlitudine brīb? cū colatione sīlitudis ptiū. Et ista est in itellectu: & ex hac vlr itelligētia itellectus elicē pōt

REVIEWS OF NEW BOOKS

THE author states that *Hydatid Cysts of the Lung in Children*[1] is the first book dealing with the disease in children. It is based on his own experience with 50 cases among 25,000 clinical histories from the children's surgical wards during a period of 20 years and on a comprehensive study of the literature.

The book, including case histories which are well illustrated, a résumé, and a bibliography, covers 300 pages. The presentation is comprehensive, the arrangement is logical, and the style is clear and forceful.

It is stated that characteristically the clear liquid of the cyst, the tænia echinococcus, does not contain albumin but may contain micro-organisms such as Bacillus coli communis, streptococcus, staphylococcus, etc., that experimental injection of fluid intravenously produces symptoms similar to those due to anaphylaxis, and that secondary echinococcosis may occur through the migration of daughter cysts developing in the wall of the mother cyst outward, from spontaneous rupture of the mother cyst, or from spilling of cyst contents during its operative removal.

The X-ray is of the greatest importance in the diagnosis of hydatid disease, but tumors, dermoid cysts, etc., must be differentiated. The author considers the complement fixation test of Ghedini conclusive if positive, but he has seen it fail in many instances. The precipitation test of Joust and the intradermal test of Trossier and Casoni have been found positive in about 90 per cent of cases. A rapid skin sensitization test is also described as very simple and useful. The author condemns diagnostic puncture as so unreliable and dangerous as to be unwarranted. Complications include infection of a cyst, rupture into a bronchus or into the pleural cavity.

Differential diagnosis includes a differentiation between malignant tumors, especially sarcoma in case of children, dermoid cysts, tracheobronchial adenopathy, tuberculosis, pleuritis, lung abscess, and liver cysts.

The prognosis in children is far more serious than in adults. In the present series it was 21.4 per cent. Bronchopneumonia was the chief cause of death in half the patients operated upon. The author states that to improve the prognosis the technique of operation should always be made as simple as possible, to endeavor to ward off the slightest risk. The practice of doing "The more showy operation in one stage for the more prudent two-stage operation" should be abandoned.

The author believes that in case of a simple cyst situated peripherally the operation should consist of opening the cyst and extracting the hydatid membrane. Operation for central cyst exposes the patient to such serious risk that it is better to wait for spontaneous rupture into a bronchus which results in a cure in 50 per cent of cases In case of ruptured cyst, the best procedure is incision and drainage.

The greatest dangers attending all thoracic operations are infection, hæmorrhage, and pneumothorax. Methods of combating their complications are discussed.

The author expresses the sane opinion that an operation in two stages or under hyperpression is safer than an open pneumothorax

CARL A. HEDBLOM, M.D.

THE American publishers, William Wood and Company, have presented us with a most acceptable volume of 585 pages on the *Report of the International Conference on Cancer*.[2] At this conference in London in July, 1928, there were more than 102 delegates from 17 countries outside of the British domains. The United States was represented by 17, Germany by an equal number, France by 13. Every British dominion sent its delegates, 25 in all, and there was a very much larger number of home delegates and members. It was, therefore, a much larger meeting than the Cancer Control Conference at Lake Mohonk, New York, which was held in September, 1926, under the auspices of the American Society for the Control of Cancer, where there were but 16 foreign delegates and about 100 delegates and members from the United States, and only 32 papers.

In the book containing the London report, there are published 128 papers, but without discussions. It is interesting to note the relative number of papers devoted to the different problems of cancer. For example, under the title "Public Action in Regard to Cancer" there are but 11 papers. These discuss the educational problem of cancer, the importance of getting the correct facts to the public, and the now universally accepted conclusion that the cure of cancer today depends upon education of the people. On the etiology of cancer there are but 13 papers. These discuss cancer research. On the other hand, there are at least 38 contributions to radiation in the treatment of cancer, while the papers devoted to the diagnosis of cancer are only 11 in number. Discussions of the actual surgical treatment or operations for cancer are included in many of the papers on radiation but are not given the same attention. In the 8 articles on cancer of the stomach, surgery and diagnosis predominate. Radium and X-rays do not seem to have entered this field as therapeutic agents. The 5 papers on sarcoma of bone are largely pathological. Surgical

[1] HYDATID CYSTS OF THE LUNG IN C[illegible]E By Marcelino Herrera Vegas, M.D., F.A.C.S., F.R.S.M. Buenos Aires S. A. Imprenta Lamb y Cia, 1928.

[2] REPORT OF THE INTERNATIONAL CONFERENCE ON CANCER, LONDON—17–20th JULY, 1928. Held under the auspices of the British Empire Cancer Campaign. New York: William Wood and Company, 1928.

treatment and radiation are both discussed. It is interesting to note that there are 5 contributions to cancer of the lung. Naturally, chemotherapy by intravenous lead received its fair attention in 14 contributions. Bell, who delivered a paper, apparently did not publish it in this volume. Just as the papers on Cancer Research registered the fact that Gye's work and conclusions have not been confirmed, so the papers on lead treatment emphasize the fact that the curative value of intravenous lead has been found to be practically nil. The conclusions of Bell were not confirmed.

This book should be in every medical library in this country, and every student of cancer, whether research worker, pathologist, surgeon, or roentgenologist, should read carefully every one of the articles because they record pretty faithfully the opinion of cancer students throughout the world up to 1928. This book should be read with the Proceedings of the Lake Mohonk Convention which were published by the Surgical Publishing Company of Chicago in 1927 and may be obtained through them or through the American Society for the Control of Cancer in New York.

The conclusions that impressed me most are that the British Empire Cancer Campaign has a larger representation of the British government and a larger active representation from the British Empire and the British Dominions than the American Society for the Control of Cancer. There are at least 100 names on the Grand Council of the British Empire Cancer Campaign, while in the American Society for the Control of Cancer there is now practically only one representative of the United States Government—an Assistant Surgeon General of the United States Public Health Service. It is my opinion, however, with which some of my colleagues do not agree, that the American Society for the Control of Cancer has done more for the actual cure of cancer than any other agency in the civilized world. The greatest criticism of the London Conference is their failure to recognize that the people must be directly educated. All cancer students throughout the world seem to agree that the cure of cancer depends upon the reduction of the time between the first symptom and the treatment, whether it is surgery or radiation. In spite of this, the chief interest of the medical profession is in the treatment of the late and usually hopeless stage of cancer. It is quite true that today the majority of cancer patients come under observation in this late deplorable stage, and it is imperative to provide for their treatment with surgery or radiation and to make further experimental attacks like Bell's intravenous lead and other therapeutic agents.

In this country we have demonstrated that the people can be actually informed and influenced to act at once. In some clinics inoperability has been reduced from more than 50 to less than 10 per cent. The actual cures from the operative treatment of cancer have increased from less than 10 to more than 60 per cent. In some clinics the percentage of precancerous lesions, especially of the mouth and skin, have increased from less than 5 to more than 65 per cent.

The medical profession throughout the civilized world must be influenced to realize the importance of the educational efforts and must aid the smaller group in creating a public opinion which will bring more financial aid to education.

The next disappointing fact, shown in both the American and the London Conferences, is the small number of educated men and women who are able to devote their full time to cancer research in proper environment and with full financial backing. Cancer will never be controlled by education alone with the therapeutic agents we have today. Through enlarged, organized, financed medical research laboratories, there must be found the cause, prevention, and cure of cancer.

Nevertheless, these two conferences, in New York in 1926 and in London in 1928, demonstrate that at the present moment the mysterious disease called cancer is gaining the attention of not only the scientific world, but of the great mass of people. An educated Mexican woman said to me a few days ago: "Five years ago none in Mexico knew anything about cancer. Today the peons are getting their correct information." In the *New York Times* of Sunday, May 5, 1929, there is the statement: "Everybody knows what cancer is."

Those who read these two books should also inform themselves on what is being done by the Commonwealth of Massachusetts through its Department of Health, and I refer you to the *American Journal of Public Health* and the *Nation's Health* for April, 1928, to an article by Dr. Herbert L. Lombard.

JOSEPH COLT BLOODGOOD.

BEITRAEGE zur Kenntnis der Beckenbrueche und Beckenluxationen[1] is a monograph in German by a Swedish surgeon. It was written at the suggestion of Prof. Gunnar Nystrom and is the only work of such size and completeness since the introduction of the roentgen-ray. The author's own material is drawn from four of the largest hospitals in Sweden and comprises 306 cases of fracture of the pelvis observed during a period of 16 years, from 1911 to 1926. The largest number of cases previously investigated by any author is 102.

The incidence of pelvic fractures is greater during the years from 20 to 60, and the large majority occurred in automobile, motorcycle, and street car accidents.

Fractures not involving the pelvic ring included 47 iliac, 20 sacral, 13 ischial and coccygeal, and 4 of the ring of the acetabulum. Fractures involving the pelvic ring included 106 pubic and ischial, 52 anterior and posterior, 4 posterior alone, and 47 through acetabulum.

[1] BEITRAEGE ZUR KENNTNIS DER BECKENBRUECHE UND BECKENLUXATIONEN; KLINISCHROENTGENOLOGISCHE UNTERSUCHUNGEN UEBER DIE ANATOMIE, DEN ENTSTEHUNGSMECHANISMUS, DIE KOMPLIKATIONEN, DIE BEHANDLUNG, UND DIE PROGNOSE. By Anders Westerborn. Uppsala: Almqvist & Wiksells, 1928.

The anatomy and mechanism of the various fractures are well described. Treatment of fractures of the ilium should be conservative even though considerable displacement is present. Lambotte is the most ardent advocate of open operative replacement and fixation, but the author's cases show that this is rarely necessary. Fractures between the crest and the body of the ilium heal in all cases without operation and need only be treated by rest in bed for 3 or 4 weeks.

Sacral fractures frequently involve nerve injuries, either through direct lesions of the nerves themselves, or compression by bone fragments, or by hæmatoma. These nerve symptoms may not appear immediately but may be delayed for several days. Most sacral fractures need only bed treatment, averaging 30 days. In case of marked displacement, bimanual reposition should be attempted, and when impossible, open operation may be required, if extensive nerve injury exists.

Fractures of the rim of the acetabulum may respond to conservative treatment. They are often caused by dislocation of the femoral head. If the fragment interferes with replacement of the head, it may require open operation. The results are sometimes unfortunate, and the prognosis should be guarded.

Fractures of the pelvic ring are more common and more interesting than those not involving the ring. Two hundred and nine cases are included in the author's series. The entire pelvis should be included in the X-ray examination of all suspected cases.

Separation of the symphysis pubis of more than 15 millimeters is certain to involve damage to the capsule or the ligaments of the sacro-iliac joints. Forty millimeters' separation will involve a severe tearing apart of at least one sacro-iliac joint.

Central dislocation of the head of the femur (through the fractured acetabulum) may be difficult or impossible to reduce. Three methods—continuous traction, manipulative reduction under anæsthesia, and open operation—are used to reduce these fractures. In 47 cases there were 10 deaths. In only one case was an open operation performed, and the result was excellent, with a shortening of only 1 centimeter and about 12 per cent permanent disability. An abstract of each of the 306 cases is appended with about 100 reproductions of roentgenograms and tracings of many others.

The author deserves great credit for his painstaking work. EDWIN W. RYERSON.

IN group five of part 3 B of Section V, *Handbuch der biologischen Arbeitsmethoden*,[1] there are four articles. The first, on "Secretins" by Adolf Bichel and Carl von Eweyk, is short and inadequate and contains no reference to work since 1923. The second, on "Morphological and Experimental Investigation of the Ovary" by Johannes Hett, is complete and thorough and will be useful to the investigator and the physician who desire to know the experimental literature on this subject. The third, on "The Method of Investigation of the Isolated Endocrine Glands," is excellent and contains eight diagrams and considerable detail on technique. It will be valuable to the investigator who desires to study isolated organs. The fourth article, on "The Preparation and Evaluation of the Parathyroid Hormone" by J. B. Collip, summarizes our knowledge of these glands and evaluates adequately their rôle in the animal organism.

A. C. I.

IT is not so many years ago that the medical world was apprised of a new movement in medicine—teamwork. In the beginning only a limited number of the departments of medicine—for instance, general surgery and internal medicine—were interested in such co-operation. Today, however, almost all departments of medicine co-operate in making diagnoses and treating patients. Urology is not an exception for we find the urologist and roentgenologist working together to secure more accurate and positive diagnoses. That this co-operation has been of special benefit to patients goes without saying and that both urologist and roentgenologist have benefited thereby is an important milestone in the development of both specialties.

Young and Waters in their section in the *Annals of Roentgenology*[2] describe the various technical developments in urological roentgenology in a most thorough manner. The different types of cystoscopic tables and cystoscopes are adequately considered. The same can truthfully be said of the methods of Roentgen diagnosis inclusive of renal fluoroscopy, the use of the roentgen-ray films at the time of operation, stereoscopy, ureterography, cystography, diverticulography, vesiculography, ampullography, vasography, and urethrography. Excellent sections on topography, anatomy, and physiology of the urinary tract are given, special emphasis being placed on the frequency and surgical importance of renal anomalies.

The results of obstructive conditions as they affect the kidney have a chapter of their own, ureteral reflux, hydronephrosis, and stricture of the urethra being especially dwelt upon to illustrate the complications which may ensue from such obstructions. The value of roentgenology in the diagnosis of obstructions at the vesical orifice—prostatic hypertrophy and contractures—as well as the diagnosis of the valves of the posterior urethra and the various roentgen-ray data obtained in the urogenital infections are not only outlined but are so carefully explained that the reader cannot but profit from a close study of the salient points which are emphasized.

[1] HANDBUCH DER BIOLOGISCHEN ARBEITSMETHODEN. Edited by Geh. Med.-Rat. Prof. Dr. Emil Abderhalden. Abt. V, Methoden zum Studium der Funktionen der einzelnen Organe des tierischen Organismus. Teil 3B, Heft 5. Berlin and Vienna: Urban & Schwarzenberg, 1928.

[2] ANNALS OF ROENTGENOLOGY; A SERIES OF MONOGRAPHIC ATLASES. Edited by James T. Case, M.D. Vol. vii—Urological Roentgenology, by Hugh H. Young, M.D., and Charles A. Waters, M.D. New York: Paul B. Hoeber, Inc., 1928.

Of great interest to every urologist is the subject of tuberculosis, and many illustrations are given to show the various types of roentgenological data obtained in this group of cases.

A subject that is presented in detail and with profuse illustrations is urinary lithiasis, a matter of great importance in the work of both urologist and roentgenologist.

In the diagnosis of tumors, whether of the kidneys or bladder, the roentgenologist is the one who can give the desired information so that no mistakes are made; especially in bladder tumors are the data obtained by cystoscopy greatly strengthened by stereoscopic cystograms.

This monograph is distinctive in that the many illustrations, which are exceedingly well executed, are so carefully arranged that the text is greatly illuminated and the real purpose of the publication is carried out. In short, a diagnostic guide is supplied that cannot fail to enlighten the roentgenologist in regard to the significance of the various diseases of the urinary tract, so that in the teamwork, already mentioned, his rank will be of the same importance as that of the urologist.

H. L. K.

THIS two volume work on *Practical Surgery of the Abdomen*[1] covers in its scope the diagnosis and treatment of surgical diseases and injuries of the abdomen and includes chapters on urology, gynecology, and some phases of obstetrics. The presentation of this material is made in the fashion of an informal discussion. The subject matter is almost exclusively diagnosis and operative technique.

There are a number of serious criticisms to be made of sections that appear to the reviewer to be fundamentally wrong. The first one concerns the chapter on inguinal hernia, which is by no means impressive. It may save time and space to limit the discussion of an operative procedure to one technique, but the Bassini operation cannot be satisfactorily applied to all so-called "simple" inguinal hernias. The use of muscle in the repair of any abdominal hernia is generally regarded as a debatable procedure. The suggestion to use even a small rubber drain to control oozing following inguinal herniotomy would find little acceptance by surgeons.

The author's method of the treatment of duodenal ulcer is certainly open to debate, when he states: "If at operation you do not see the expected ulcer, but are satisfied that your patient has shown all the symptoms of it, and the X-ray diagnosis is fairly positive, do not lose time opening the duodenum, looking for the ulcer. Simply perform a gastroenterostomy and your patient will get well."

In his section on bile tract surgery, the author states that even with a stone in the common duct, he leaves the gall bladder alone if the latter "does not look diseased." He suggests the old duodenal mobilization of Kocher, now regarded as far inferior to transduodenal choledochotomy, but does not describe the latter.

The description of technique is not always sufficiently clear to give the unfamiliar reader a clear idea of the subject. For instance, without identifying it by name, in his description of the Rammstedt pyloroplasty for congenital pyloric stenosis, he describes "an incision over the tumor two to two and one-half inches long," but fails to mention that the obstruction is only overcome by blunt stripping of the muscularis from the mucosa sufficiently to permit the latter to prolapse through the opening.

There are hundreds of illustrations in the text, but the majority are entirely too "sketchy" to serve any useful purpose. This applies particularly to the chapters on stomach and colon.

By way of summary, it may be said that the author has an extensive compilation of material, but lack of care and accuracy in its presentation make it of relatively slight teaching or reference value.

J. R. BUCHBINDER.

WHILE labeled *Recent Advances in Surgery*, this small volume[2] is really a brief manual or surgical compend. Its subject matter is more or less limited to such special surgical topics as have occupied a prominent place in the literature during the past decade. Shock, cancer, neurosurgery, peritoneum, gall bladder, and other subjects are considered.

The text is nicely written and well arranged. It is accurate and fairly well abreast of contemporary literature and would make a handy summary for the average senior student in medicine.

J. R. BUCHBINDER.

IN the ninth and the last volume of Schwalbe's system on *diagnostic and therapeutic errors and their avoidance*,[3] the editor, in making this announcement, expresses the hope that the publication has accomplished its purpose, that of assisting the general practitioner in the matter of diagnosis and correct therapy. If some of the chapters were dealt with in an incomplete manner, the strictures he avers were imposed by the editor in view of the general character of the work. The publication was begun in 1917. Those parts devoted to internal medicine have seen a second edition. Some of the volumes have been translated into the Russian, Spanish, and Italian. Professor Schwalbe is to be congratulated upon the completion of so meritorious and important a piece of literary work. While some of the chapters are admittedly not all inclusive, the reviewer wishes particularly to call attention to such splendid contributions as that of Payr on appendicitis, appearing in volume 8. Here is a complete

[1] PRACTICAL SURGERY OF THE ABDOMEN. By George H. Juilly, M.D. With a foreword by W. Wayne Babcock, M.D. Vols. i and ii. Philadelphia: F. A. Davis Company, 1928.

[2] RECENT ADVANCES IN SURGERY. By W. Heneage Ogilvie, M.A., M.D., M.Ch. (Oxon.), F.R.C.S. (Eng.). Philadelphia: P. Blakiston's Son & Company, 1928.

[3] DIAGNOSTISCHE UND THERAPEUTISCHE IRRTUEMER UND DEREN VERHUETUNG; CHIRURGIE. Edited by Prof. Dr. J. Schwalbe. Vol. ix. Leipzig: Georg Thieme, 1928.

monograph of some 130 pages replete with illustrations and written in an authoritative and exhaustive style. It is the best piece of writing on the subject that has come to the reviewer's attention. It contains most valuable information for the surgeon no less than for the general practitioner. In the same volume one finds a contribution by Kirschner on peritonitis and by Holbaum on hernia. Both, while not on the same plane of excellence as Payr's contribution, are well written and abreast of the most advanced conceptions.

The contents of the last volume comprise a chapter on the diseases of the diaphragm, on internal hernia, and on the intestinal canal by Heller; on the diseases of stomach and duodenum by Holbaum; and on the intestinal obstruction by Kleinschmidt. They are well written and contain a great deal of useful and practical information and that despite the fact that some of them deal with rather unusual conditions, such as the diaphragmatic hernia, Meckel's diverticulum, and internal herniae. Particularly well written is the chapter by Kleinschmidt on ileus. It is on a par with the already mentioned classical contribution of Payr on appendicitis. Such contributions derive their value from the fact that the statistics on ileus will show little improvement until the general practitioner learns to recognize early the symptoms of this condition. The symptomatology of the condition is treated in a most masterly manner. Running through the entire discussion, like a red line, is the admonition "operate early."

To those who read German the volume offers authoritative and well arranged information of value to both the general practitioner and the surgeon. The subject matter is of the most practical character dealing with the diagnosis and treatment. The practical character of the information offered will undoubtedly help greatly to improve our means of early diagnosis and therefore our operative results. The desirability of a similar work written in English appears logical.

GEORGE HALPERIN.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

PHYSICAL THERAPEUTIC TECHNIC. By Frank Butler Granger, A.B., M.D. With a Foreword by William D. McFee, M.D. Philadelphia and London: W. B. Saunders Company, 1929.

PRINCIPLES OF PATHOLOGY FOR PRACTITIONERS AND STUDENTS. By H. D'Arcy Power, M.D., F.R.P.S., and William W. Hala, M.D. New York and London: D. Appleton & Company, 1929.

THE MOBILIZATION OF ANKYLOSED JOINTS BY ARTHROPLASTY. By W. Russell MacAusland, M.D., and Andrew R. MacAusland, M.D. Philadelphia: Lea & Febiger, 1929.

LEHRBUCH DER DIAGNOSTISCHEN UND OPERATIVEN CYSTOSKOPIE. By Dr. Eugen Joseph. Berlin: Julius Springer, 1929.

A SHORTER SURGERY; A PRACTICAL MANUAL FOR SENIOR STUDENTS. By R. J. McNeill Love. New York: William Wood & Company, 1929.

PRACTICAL CHIROPODY. By E. G. V. Runting, F.I.S. Ch. St. Louis: C. V. Mosby Company, 1929.

DISEASES OF THE THYROID GLAND. By Arthur E. Hertzler, M.D. With a Chapter on Hospital Management of Goiter Patients, by Victor E. Chesky, M.D. 2d ed. St. Louis: C. V. Mosby Company, 1929.

DISEASES AND DEFORMITIES OF THE SPINE AND THORAX. By Arthur Steindler, M.D., F.A.C.S. St. Louis: C. V. Mosby Company, 1929.

BIOLOGIE UND PATHOLOGIE DES WEIBES; EIN HANDBUCH DER FRAUENHILKUNDE UND GEBURTSHILFE. By Josef Halban and Ludwig Seitz. Lieferung 43. Berlin and Vienna: Urban & Schwarzenberg, 1929.

PRACTICE OF SURGERY. Edited by Dean Lewis, M.D., Sc.D. Vol. vi. Thyroid Gland, Parathyroid, Stomach, Duodenum, Gastro-Enteroptosis, Spleen. Hagerstown, Md.: W. F. Prior Company, Inc., 1929.

MORTALITY STATISTICS, 1926. Part 1. Department of Commerce, Bureau of the Census. Washington: United States Government Printing Office, 1929.

THE INTERNATIONAL MEDICAL ANNUAL; A YEAR BOOK OF TREATMENT AND PRACTITIONER'S INDEX. Forty-Seventh Year. New York: William Wood and Company, 1929.

REFLECTIONS AND OPERATIONS. By Sir John O'Conor, K.B.E., M.A., M.D. (Dub. Univ.) With a Foreword by Herbert J. Paterson, C.B.E., M.C., M.D. (Camb.), F.R.C.S. (Eng.). London: Baillière, Tindall and Cox, 1929.

PROGRESSIVE RELAXATION; A PHYSIOLOGICAL AND CLINICAL INVESTIGATION OF MUSCULAR STATES AND THEIR SIGNIFICANCE IN PSYCHOLOGY AND MEDICAL PRACTICE. By Edmund Jacobson, A.M., Ph.D., M.D. Chicago: University of Chicago Press, 1929.

THE MEDICAL CLINICS OF NORTH AMERICA. Vol. 12, No. 6. Index Number. Philadelphia and London: W. B. Saunders Company, 1929.

SURGICAL PATHOLOGY. By William Boyd, M.D., M.R.C.P. (Ed.), Dipl. Psych., F.R.S. (Can.). 2d ed. Philadelphia and London: W. B. Saunders Company, 1929.

THERAPY OF PERSONAL INFLUENCE; AN A B C OF TREATMENT BY PERSONAL INFLUENCE, SUGGESTION, MEDICAL HYPNOSIS, AND PSYCHOMAGNETIC METHODS. By Edwin Hopewell-Ash, M.D. London: Published privately, 1929.

ANNUAL REPRINT OF THE REPORTS OF THE COUNCIL ON PHARMACY AND CHEMISTRY OF THE AMERICAN MEDICAL ASSOCIATION FOR 1928. Chicago: American Medical Association, 1929.

CHRONIC (NON-TUBERCULOUS) ARTHRITIS; PATHOLOGY AND PRINCIPLES OF MODERN TREATMENT. By A. G. Timbrell Fisher, M.C., F.R.C.S. (Eng.). New York: The MacMillan Company, 1929.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

FRANKLIN H. MARTIN, Chicago, *President* MERRITTE W. IRELAND, Washington, *President-Elect*

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ALFRED A. STRAUSS

CHICAGO SURGEONS PLAN FOR THE 1929 CLINICAL CONGRESS

CHICAGO'S popularity as a clinical center will be evidenced in the plans for the nineteenth annual Clinical Congress of the American College of Surgeons to be held in Chicago, October 14–18. The number of advance registrations already received following the publication of the first notice of plans for the Congress strongly indicates an unusually large attendance at this year's meeting.

Under the leadership of a strong and representative committee of clinicians, the surgeons of Chicago are planning a program of clinics and demonstrations for the entertainment of Fellows of the College and their guests that will completely portray the clinical activities of Chicago in all departments of surgery, including general surgery, gynecology, obstetrics, orthopedics, urology, and surgery of the eye, ear, nose, throat, and mouth.

The clinical program being prepared schedules operative clinics and demonstrations in the hospitals for Monday afternoon beginning at 2 o'clock and for each morning and afternoon of the following four days. A preliminary program is to be published in the next issue of SURGERY, GYNECOLOGY AND OBSTETRICS.

Clinics and demonstrations will be given daily at the following hospitals: Alexian Brothers, Augustana, Billings Memorial, Chicago Memorial, Children's Memorial, Columbus, Cook County, Eye, Ear, Nose, and Throat, Evangelical Deaconess, Garfield Park, Grant, Henrotin, Illinois Central, Illinois Eye and Ear Infirmary, Illinois Masonic, Lake View, Lutheran Deaconess, Lutheran Memorial, Lying-In, Mercy, Mt. Sinai, Municipal Tuberculosis Sanitarium, John B. Murphy, North Chicago, Passavant Memorial, Post-Graduate, Presbyterian, Ravenswood, Michael Reese, Research and Educational, St. Anthony's, St. Bernard's, St. Joseph's, St. Luke's, St. Mary's, Shriners', South Shore, University, Washington Boulevard, Washington Park, Wesley Memorial, West Side. The program will also include demonstrations in the laboratories of the medical schools: Northwestern University, University of Chicago, Rush Medical College, University of Illinois, Loyola University.

A special feature of the clinical program will be a series of clinical demonstrations at headquarters at the Stevens Hotel on Tuesday and Wednesday afternoons, from 2 to 5 o'clock, presented by outstanding surgeons of the American continent.

The sub-committee in charge of the section on surgery of the eye, ear, nose, and throat, in addition to arranging for clinics and demonstrations in the hospitals for each morning and afternoon of the Congress, is arranging for two evening scientific meetings—on Tuesday evening a series of papers dealing with surgery of the eye, and on Wednesday evening papers treating of surgery of the ear, nose, and throat. Complete details are to be published in an early issue.

The Executive Committee of the Congress is preparing programs for a series of evening meetings. At the Presidential Meeting on Monday evening in the ballroom of the Stevens Hotel, the president-elect, Major General Merritte W. Ireland, surgeon-general of the army, will be inaugurated and deliver the annual address. On the

same evening Dr. D. P. D. Wilkie, professor of surgery in the University of Edinburgh, will deliver the Murphy oration on surgery. Programs for scientific meetings on Tuesday, Wednesday, and Thursday evenings are in course of preparation, at which distinguished surgeons from the United States and Canada and eminent surgeons from abroad will present papers dealing with surgical subjects of present-day importance. On Friday evening at the annual Convocation of the College, the 1929 class of candidates for Fellowship in the College will be received.

A program has been outlined for a conference on traumatic surgery on Friday with sessions both morning and afternoon. Leaders in industry, education, and labor, together with representatives of indemnity companies, surgeons, and hospital administrators will contribute to the discussion. The chairman of the committee on traumatic surgery will report on the work of the committee in recent years and outline future activities in this department of the College work.

An interesting program of papers, round table conferences and practical demonstrations dealing with many of the problems related to the hospital standardization program of the College and hospital efficiency in general is being prepared for the annual hospital conference which opens at 10 o'clock on Monday morning in the grand ballroom of the Stevens Hotel. The conference will hold sessions on Monday afternoon and on Tuesday and Wednesday mornings and afternoons. The program is planned to interest surgeons, hospital trustees, executives, nurses and hospital personnel generally, and the invitation to attend is extended to all persons interested in the hospital field.

At the annual meeting of the College to be held on Thursday afternoon, beginning at 2 o'clock, formal reports of the activities of the College will be presented by the officers and several standing committees. The major portion of the afternoon will be devoted to a symposium on cancer with contributions by distinguished surgeons and research workers, dealing with various aspects of the problem.

General headquarters for the Congress will be established at the Stevens Hotel, located on Michigan Avenue between Seventh and Eighth Streets, where the grand ballroom and many other large rooms have been reserved for the exclusive use of the Congress for scientific meetings, conferences, registration and ticket bureaus, bulletin boards, exhibits, executive offices, etc. The grand ballroom will be utilized for the evening meetings, hospital conferences, and other large gatherings.

LIMITED ATTENDANCE

Attendance at the Chicago session will be limited to a number that can be comfortably accommodated at the clinics, the limit of attendance being based upon the result of a survey of the amphitheaters, operating rooms, and laboratories in the hospitals and medical schools to determine their capacity for accommodating visitors. Under this plan it will be necessary for those who wish to attend to register in advance.

Attendance at all clinics and demonstrations will be controlled by means of special clinic tickets, which plan provides an efficient means for the distribution of the visiting surgeons among the several clinics, and insures against overcrowding, as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

REGISTRATION FEE

A registration fee of $5.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued, which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card, which is non-transferable, must be presented to secure clinic tickets and admission to the evening meetings.

REDUCED RAILWAY FARES

The railways of the United States and Canada have authorized reduced fares on account of the Chicago session of the Clinical Congress so that the total fare for the round trip will be one and one-half the ordinary first-class one-way fare. To take advantage of the reduced rates it is necessary to pay the full one-way fare to Chicago, procuring from the ticket agent when purchasing ticket, a "convention certificate" which certificate is to be deposited at headquarters for the visé of a special agent of the railways. Upon presentation of a viséd certificate to the ticket agent in Chicago not later than October 30th a ticket for the return journey by the same route as traveled to Chicago may be purchased at one-half the regular fare.

In the eastern, central, and southern states and eastern provinces of Canada, tickets may be purchased between October 10th and 18th; in southwestern and western states between October 9th and 17th, and in the far western states and western provinces of Canada between October 6th and 14th. The return journey from Chicago must be begun not later than October 30th.

The reduction in fares does not apply to Pullman fares, nor to excess fares charged for passage on certain trains. Local railroad ticket agents will supply detailed information with regard to dates of sale, rates, routes, etc. Stop-overs on both the going and return journeys may be had within certain limits.

Full fare must be paid from starting point to Chicago, and it is essential that a "convention certificate" be obtained from the agent from whom the ticket is purchased. These certificates are to be signed by the general manager of the Clinical Congress and viséd by a special railroad agent in Chicago during the meeting. No reduction in railroad fares can be secured except in compliance with the regulations outlined and within the dates specified. It is important to note that the return trip must be made by the same route as that used to Chicago and that the certificate must be presented during the meeting and return ticket purchased and used not later than October 30th.

It will be noted that the arrangement outlined above, extending the return limit to October 30th, allows for an additional twelve days following the Clinical Congress that may be devoted to visiting other clinical centers in the middle west.

An exception to the above arrangement is to be noted in the case of persons traveling from points on the Pacific Coast and certain western states and British Columbia, who will be able to purchase round trip summer excursion tickets which will be on sale up to and including September 30th with a final return limit of October 31st. The summer excursion fare is somewhat lower than the convention fare mentioned above, but is available only in certain of the far western states and British Columbia. Tickets sold at summer excursion rates permit traveling to Chicago via one direct route and returning via another direct route, with liberal stop-over privileges.

CHICAGO HOTELS AND THEIR RATES

In recent years a number of fine large hotels have been built in Chicago, among which is the Stevens with its 3000 guest rooms. Ample first-class hotel facilities are available, many of the hotels being located within short walking distance of the headquarters hotel.

	Minimum Rates with Bath	
	Single Room	Double Room
Auditorium, Michigan Ave. and Congress St.	$3.50	$5.00
Belmont, 3100 Sheridan Road	4.00	5.00
Bismarck, 175 W. Randolph St.	3.50	5.00
Blackstone, Michigan Ave. and East 7th St.	5.00	10.00
Chicago Beach, Hyde Park Blvd. at the Lake	5.00	5.00
Congress, Michigan Ave. and Congress St.	4.00	6.00
Drake, Michigan Ave. and Walton Place	5.00	6.00
Edgewater Beach, 5349 Sheridan Road	4.00	6.00
Fort Dearborn, Van Buren and LaSalle Sts.	1.95	3.00
Great Northern, Jackson Blvd. and Dearborn	3.50	4.50
Knickerbocker, Walton Place and Michigan	3.00	5.00
Lake Shore Drive, 181 Lake Shore Drive	5.00	7.00
LaSalle, LaSalle and Madison Sts.	3.00	4.50
Morrison, Clark and Madison Sts.	2.50	5.00
Palmer, Monroe and State Sts.	4.00	7.00
Parkway, 2100 Lincoln Park West	3.00	5.00
Pearson, St. Clair and Pearson Sts.	3.50	5.00
Sherman, Clark and Randolph Sts.	3.00	4.00
Stevens, Michigan Ave. and 7th St.	3.50	6.00
Webster, Lincoln Park West at Webster Ave.	3.00	5.00